

Assessment of the Restoration Activities on Water Balance and Water Quality at Last Chance Creek Watershed Using Watershed Environmental Hydrology (WEHY) Model

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Feather River CRM

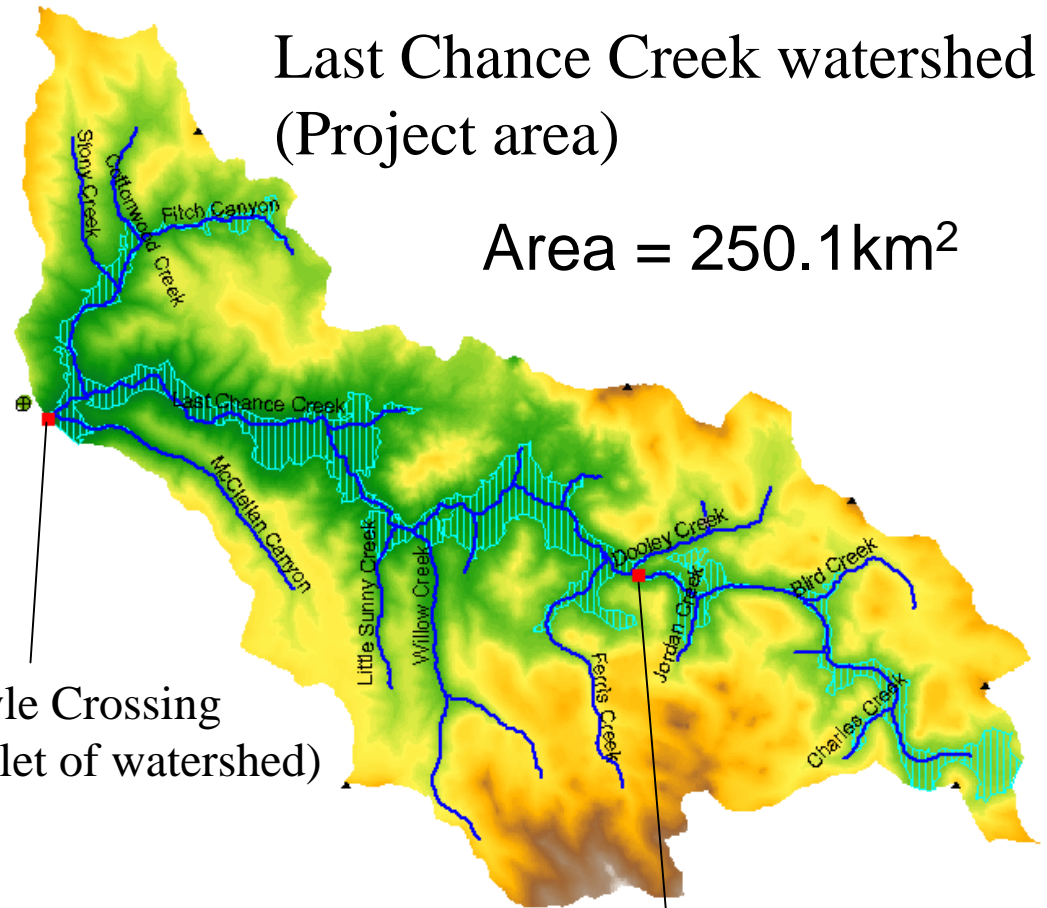
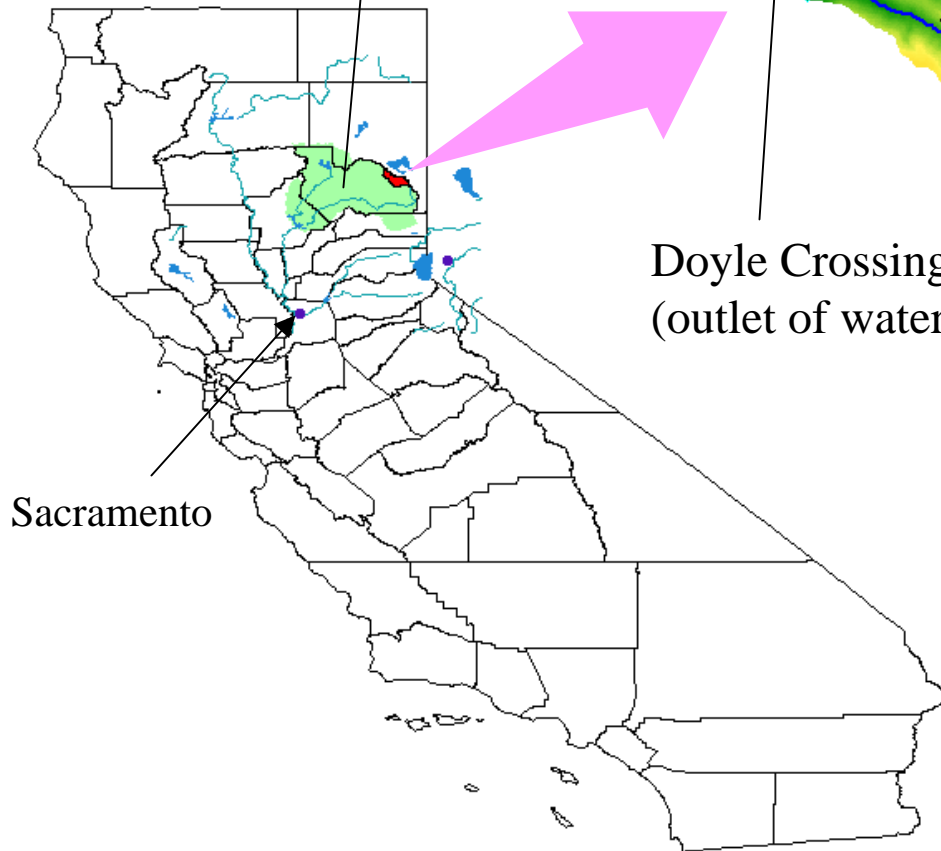
Last Chance Creek watershed (Project area)

Area = 250.1km²

Feather River Basin

Doyle Crossing
(outlet of watershed)

Million \$ Bridge

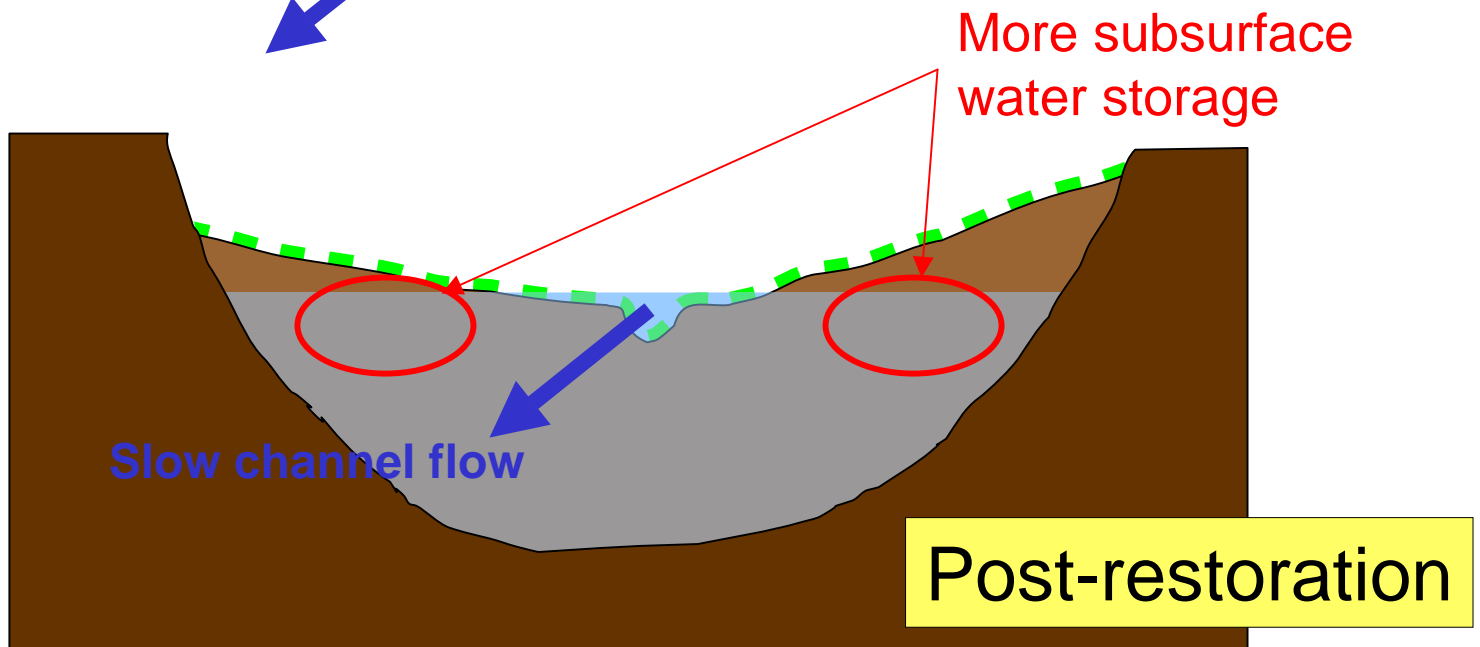
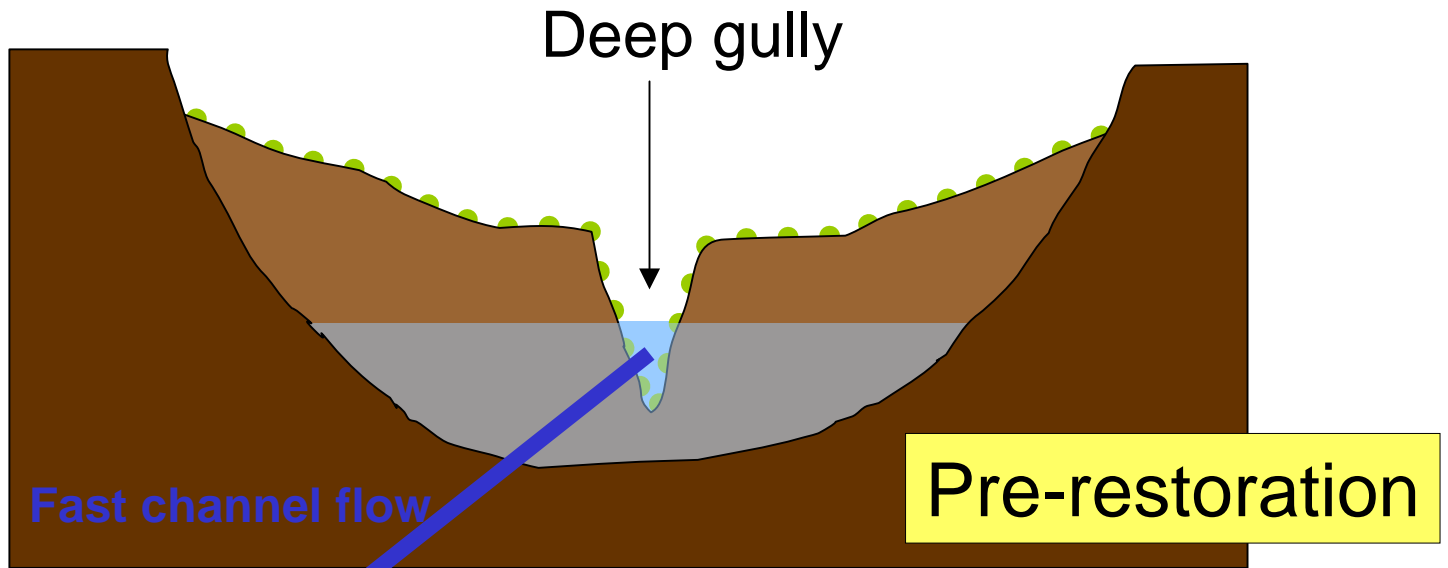




← **Pre-restoration
condition**
(May 5, 2002)
The deep gully due to
instream erosion induces
low groundwater level.

**Post-restoration
condition** →
(July 29, 2004)
The deep gully was filled,
and a shallow channel
was dug nearby.





ISSUES TO ASSESS FOR RESTORATION ACTIVITIES IN THE LAST CHANCE CREEK WATERSHED

1. How does the restoration affect flood flows?
2. How does the restoration affect flows during the summer months?
3. How does the restoration affect the groundwater storage within the watershed?
4. How does the restoration affect sediment discharge from the watershed to downstream?

Use of a Watershed Model in NPS Studies

Watershed model provides a tool for watershed evaluation
to help
protect and restore source areas for
water supply and flood control
and
to reduce NPS substance releases from these areas.

Model can identify source areas (sediment, nutrients, groundwater recharge, runoff)

Model can evaluate potential restoration activities for effectiveness at any watershed

Model can assess any land use/management scenarios

WEHY (Watershed Environmental Hydrology) Model

is a

physically-based, spatially-distributed

continuous simulation model

of

hydrologic and environmental processes.

It was peer-reviewed and published

(Nov/Dec 2004 issue of Journal of Hydrologic Engineering).

INPUT

Precipitation

Snowfall, Temperature, Wind Speed,
Relative Humidity

Parameter values related to
Topography, Soil, Land Use
Land Cover characteristics

Rainfall

I. HYDROLOGIC MODULE

II. ENVIRONMENTAL MODULE

Hillslope Processes

Stream and Regional
Groundwater Processes

OUTPUT

Streamflow Hydrograph/profile,
GW Table Elev/Hydraulic Head
Soil water content, ET, Inf. rates
at any desired location
within a watershed

Water
temperature at
any desired
location within a
watershed

Sediment and
Nutrient load at
any desired
location within a
watershed

Pesticide load at
any desired
location within a
watershed

Interception and
Evapotranspiration Model

Unsaturated flow and Infiltration
Model

Subsurface Stormflow

Regional
Groundwater

Stream Network Flow

Solar Radiation + Snow
Accumulation + Snowmelt
Models

Overland flow
(Sheet and Rill Flow)

Hillslope Erosion/Sediment,
and Nutrient Transport

Hillslope Pesticide Transport

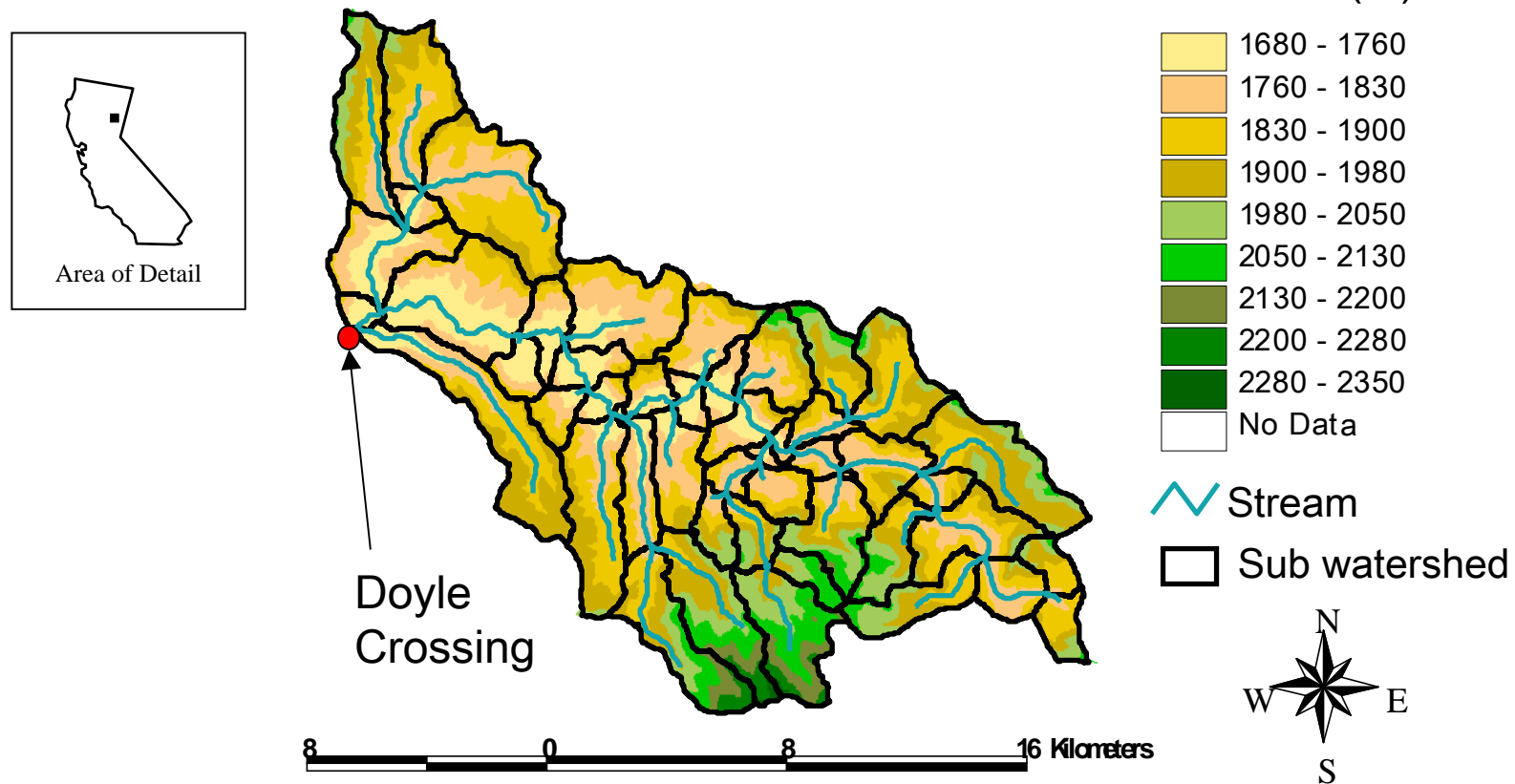
Hillslope
Surface/Subsurface/GW
Water Temperature

In-stream Erosion/Sediment,
and Nutrient Transport

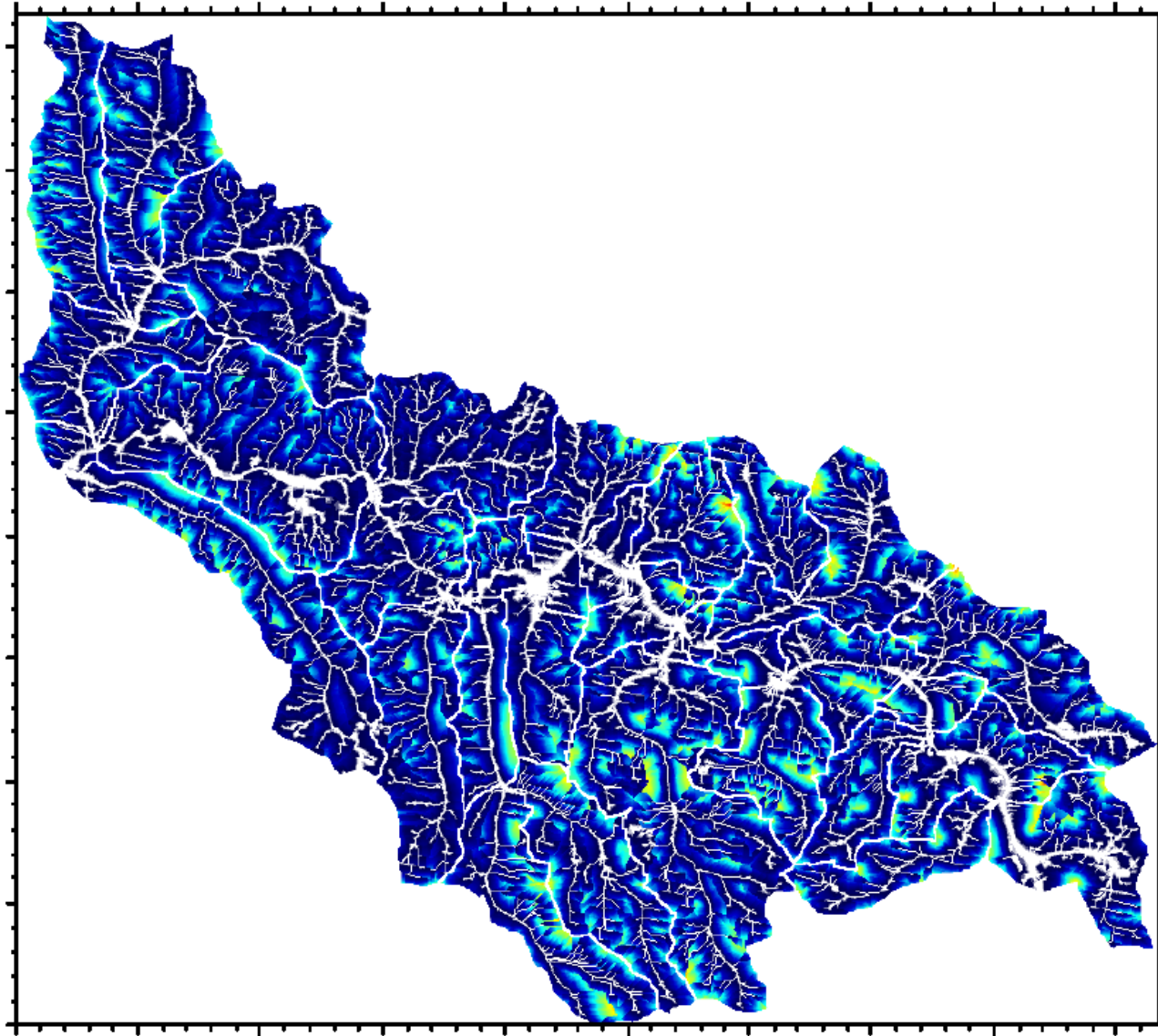
In-stream Pesticide Transport

In-stream Temperature
Transport

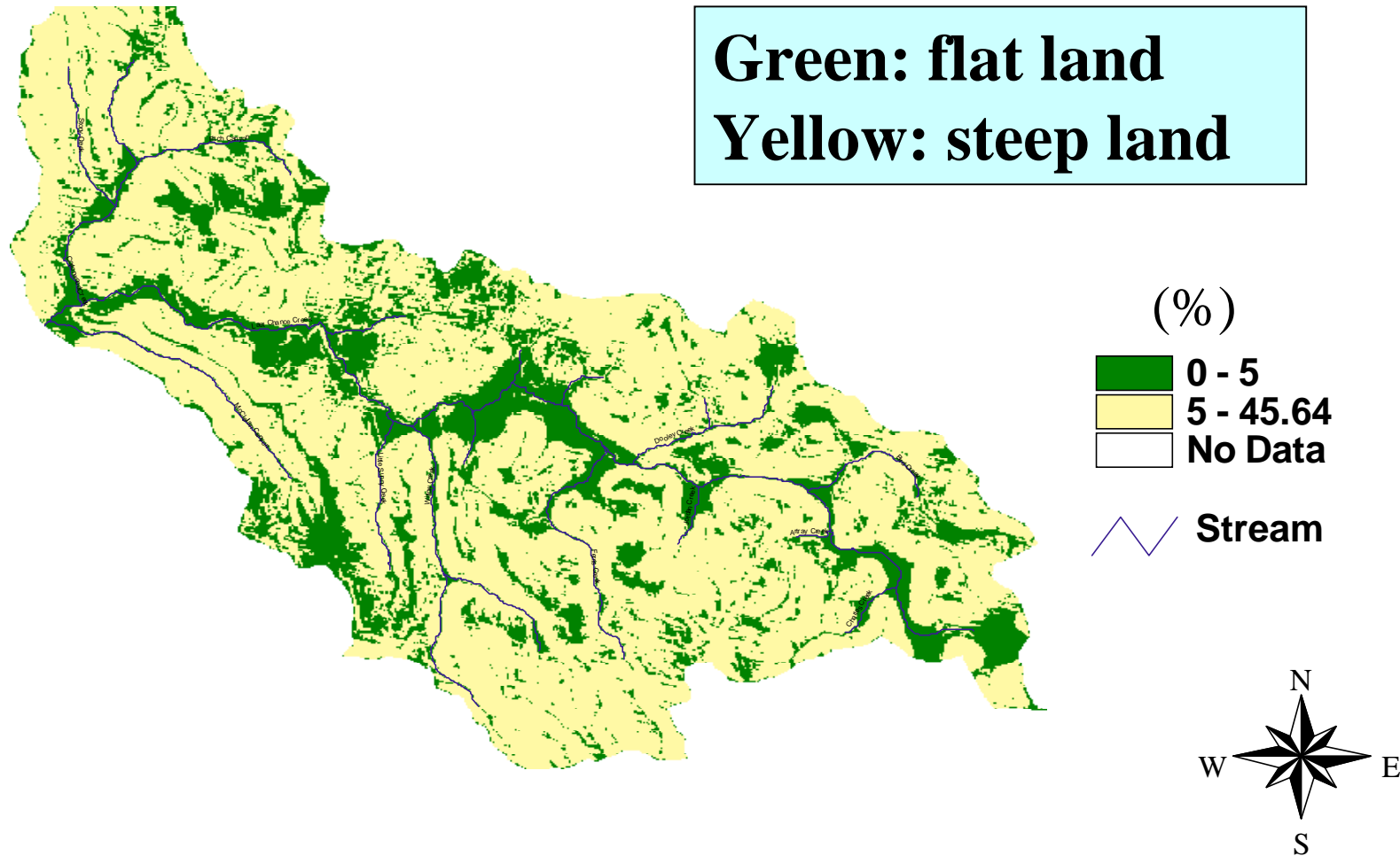
Develop the GIS (Geographical Information System) for the watershed based upon existing databases and build model parameters



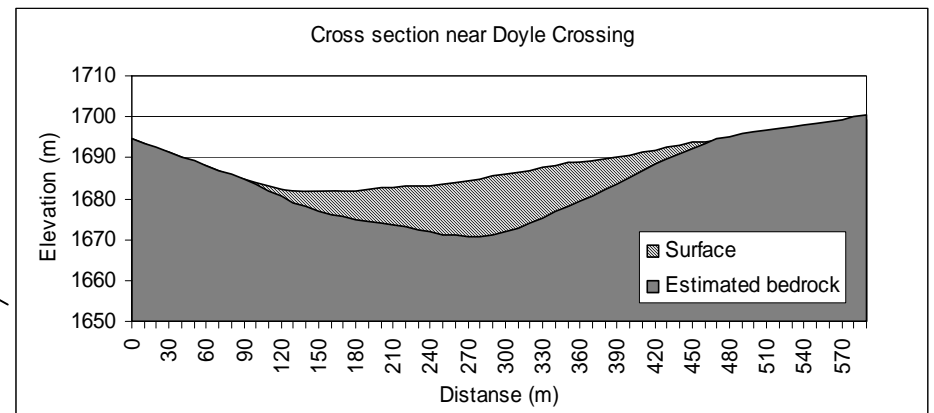
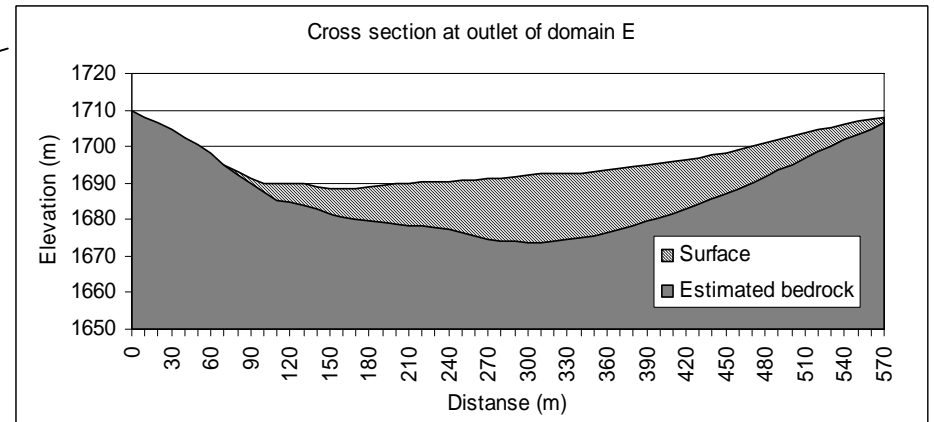
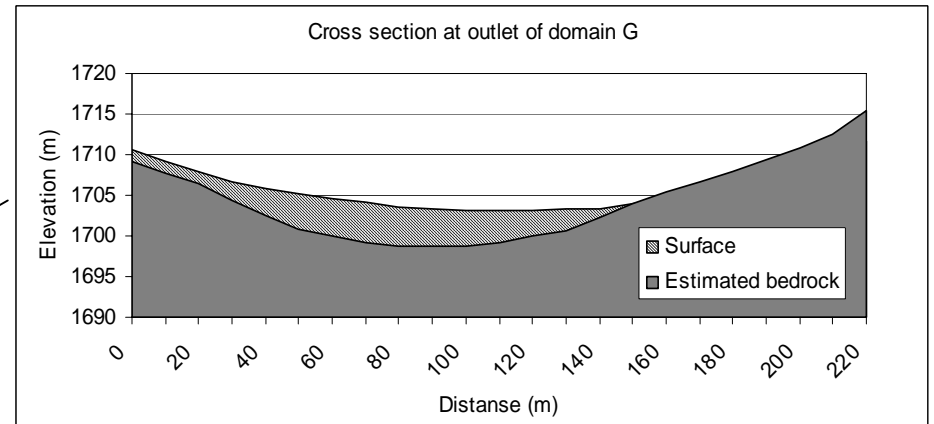
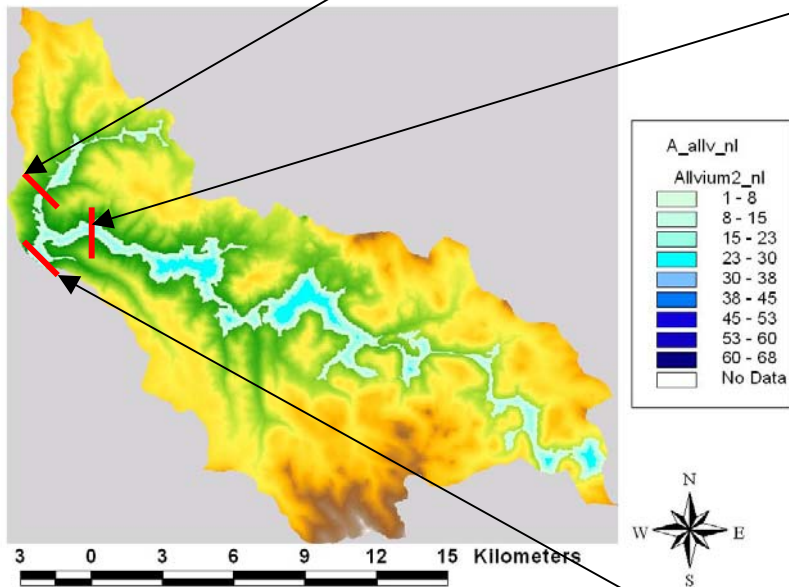
Stream network at Last Chance Creek watershed



Slope map and delineation of meadow land



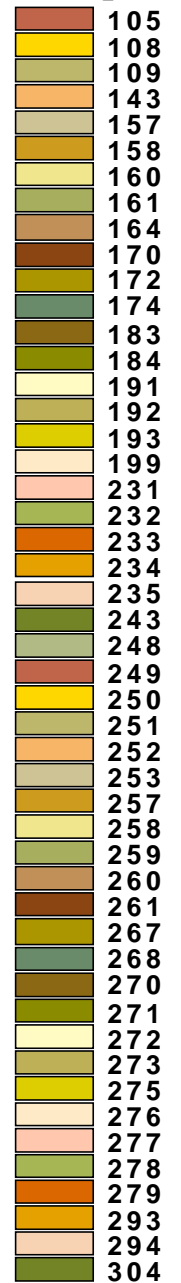
Groundwater Flow Domain



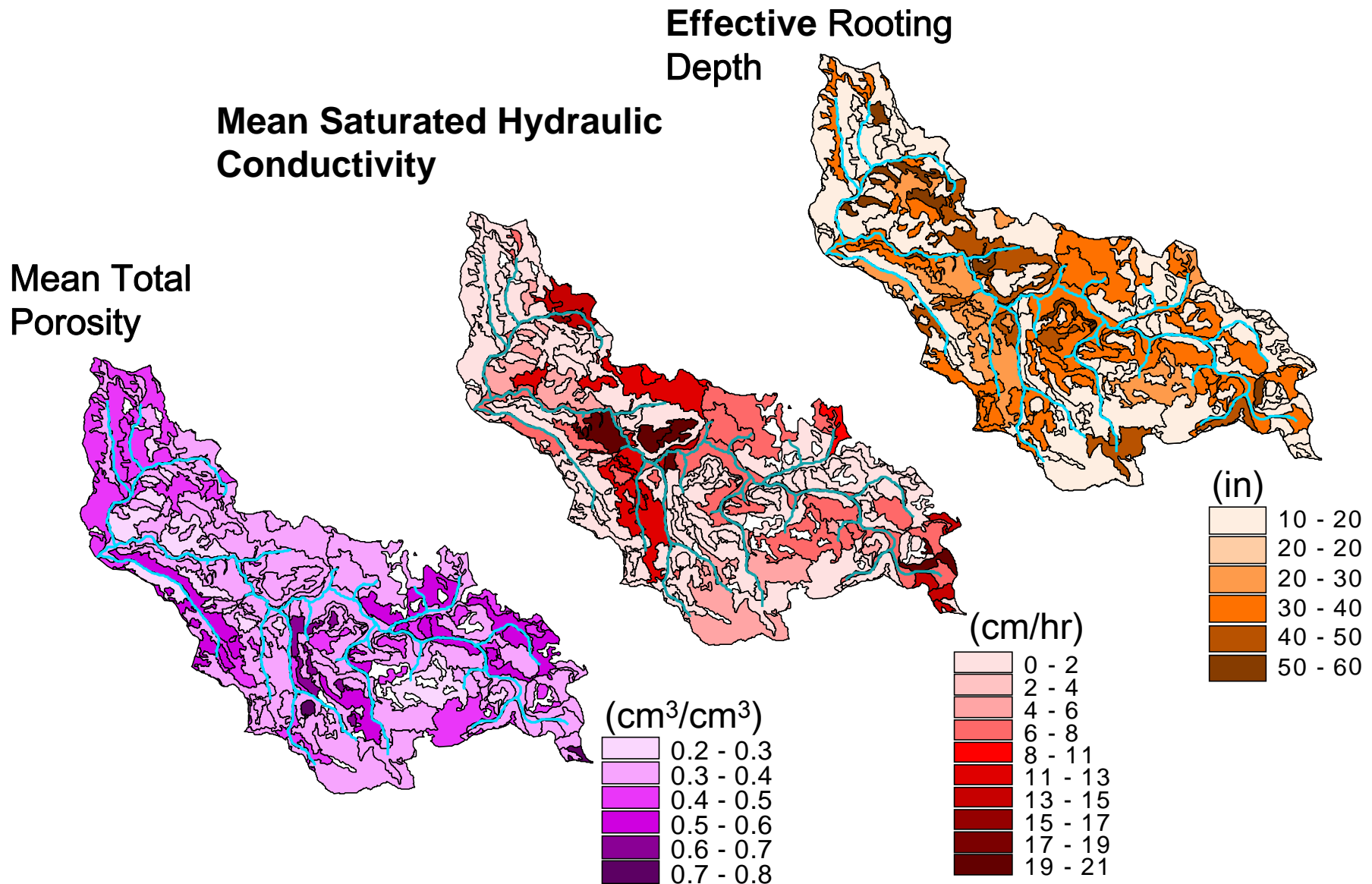
Soil database (USFS soil survey)



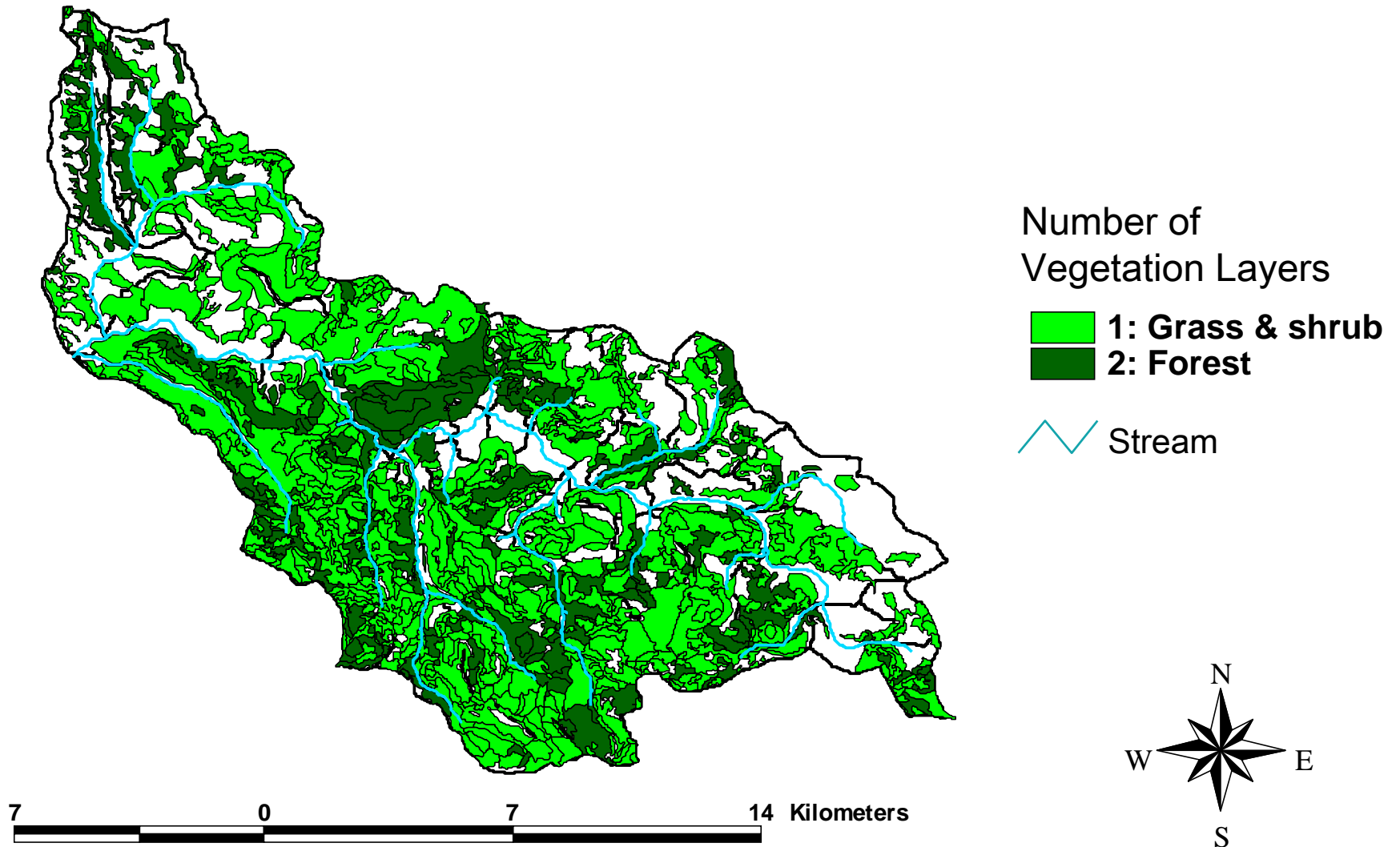
Soil map unit

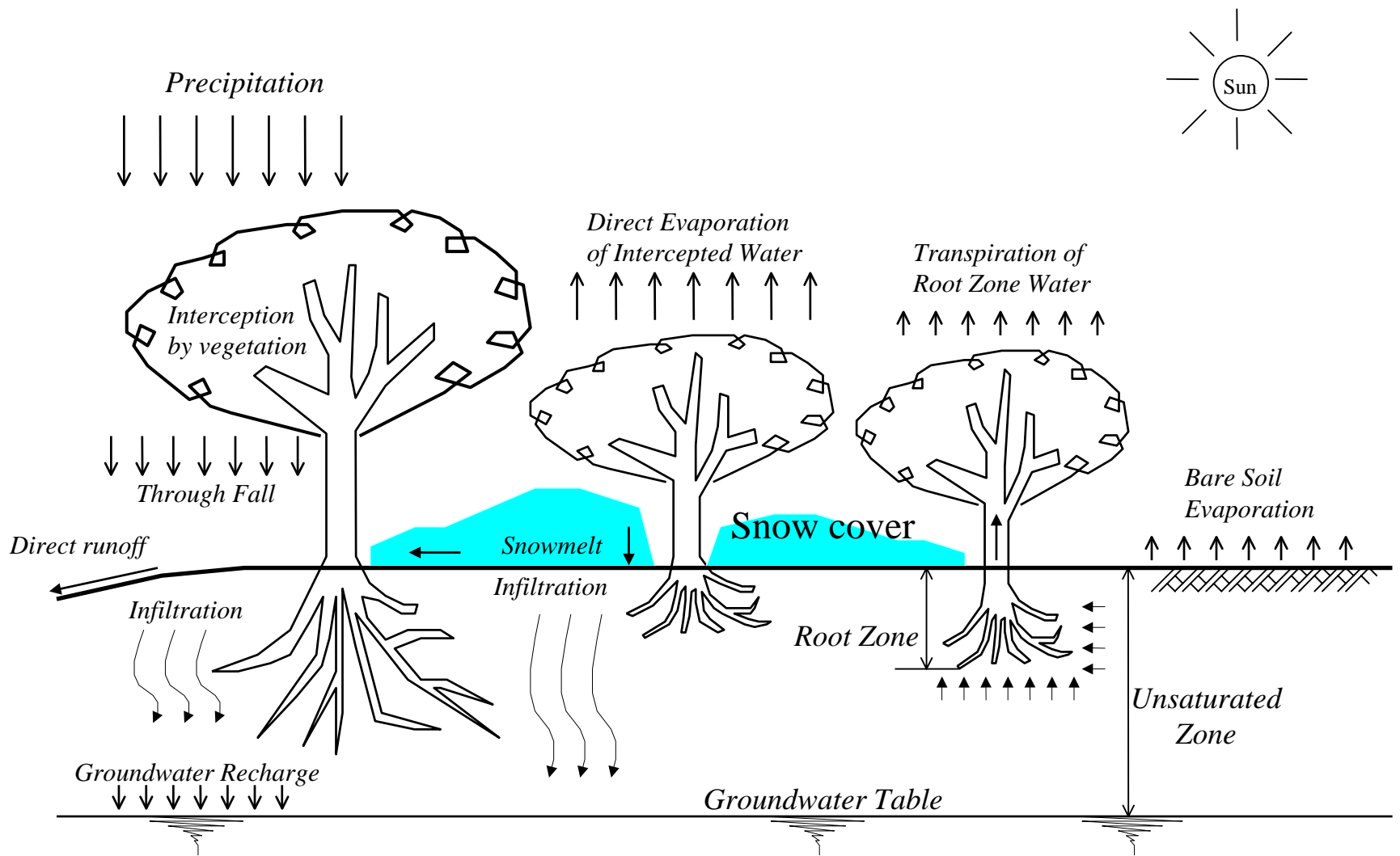


Estimated soil parameters for WEHY model over Last Chance Creek watershed (selected)

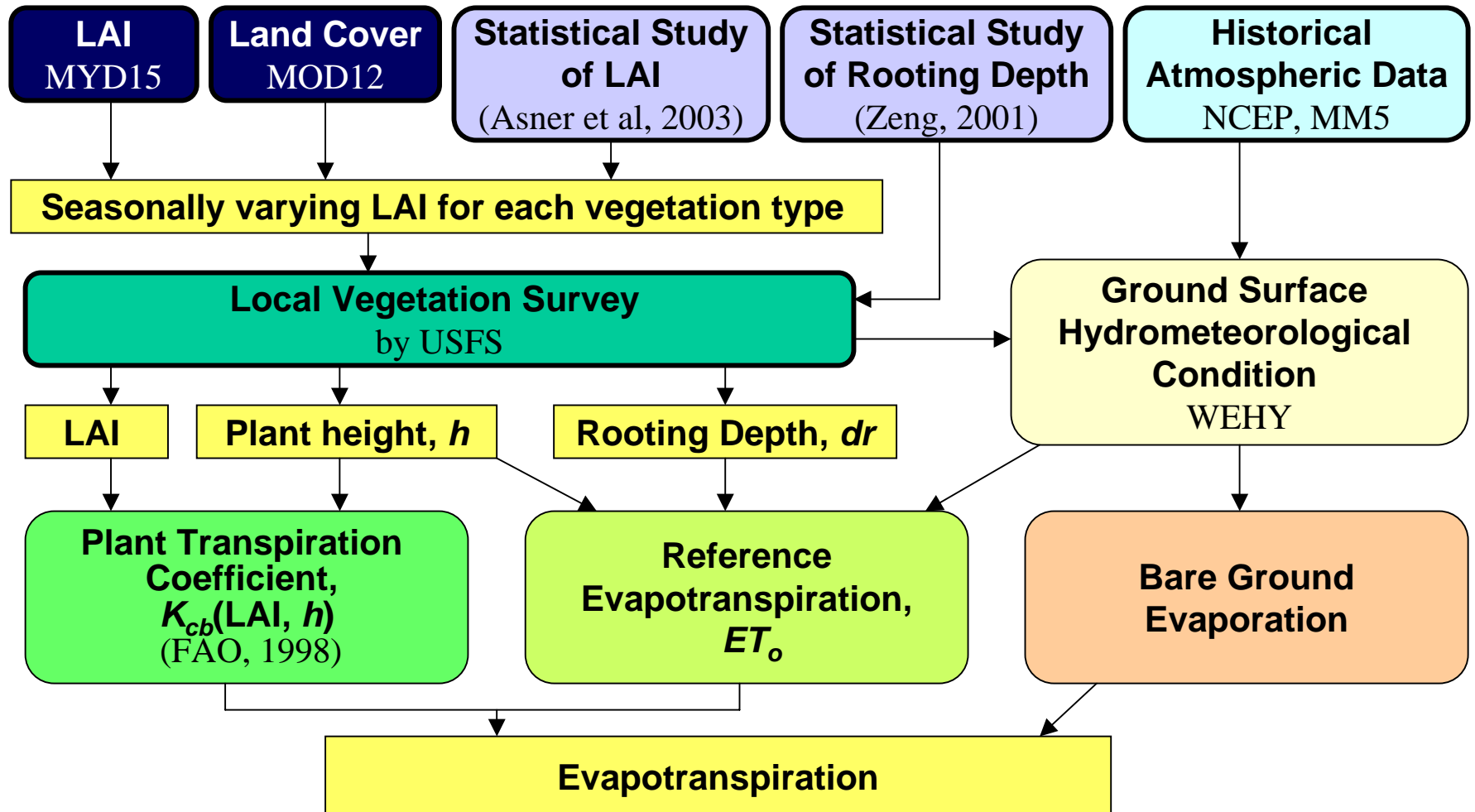


Vegetation Map (USFS)

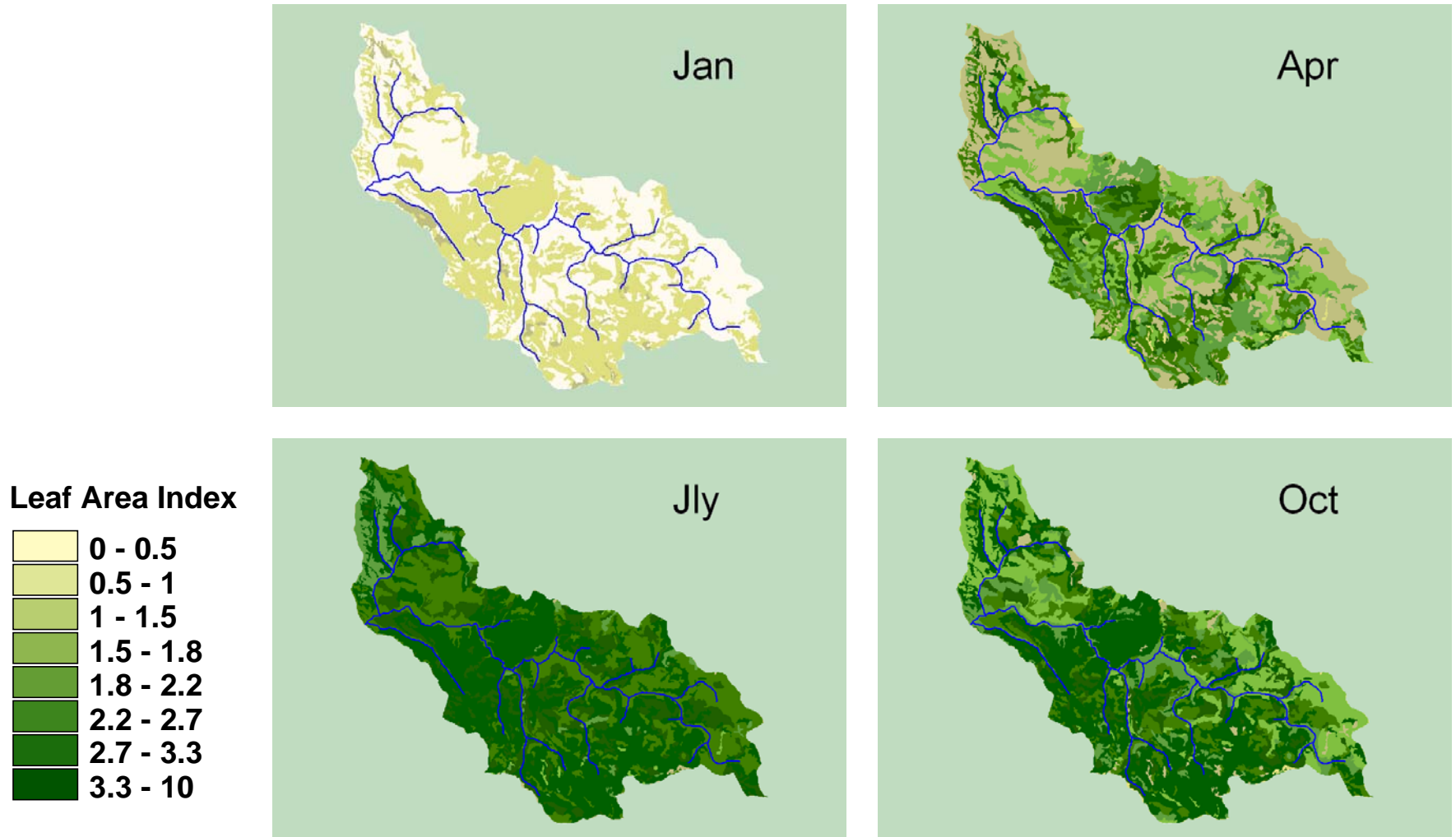




Methodology for evapotranspiration with natural vegetation

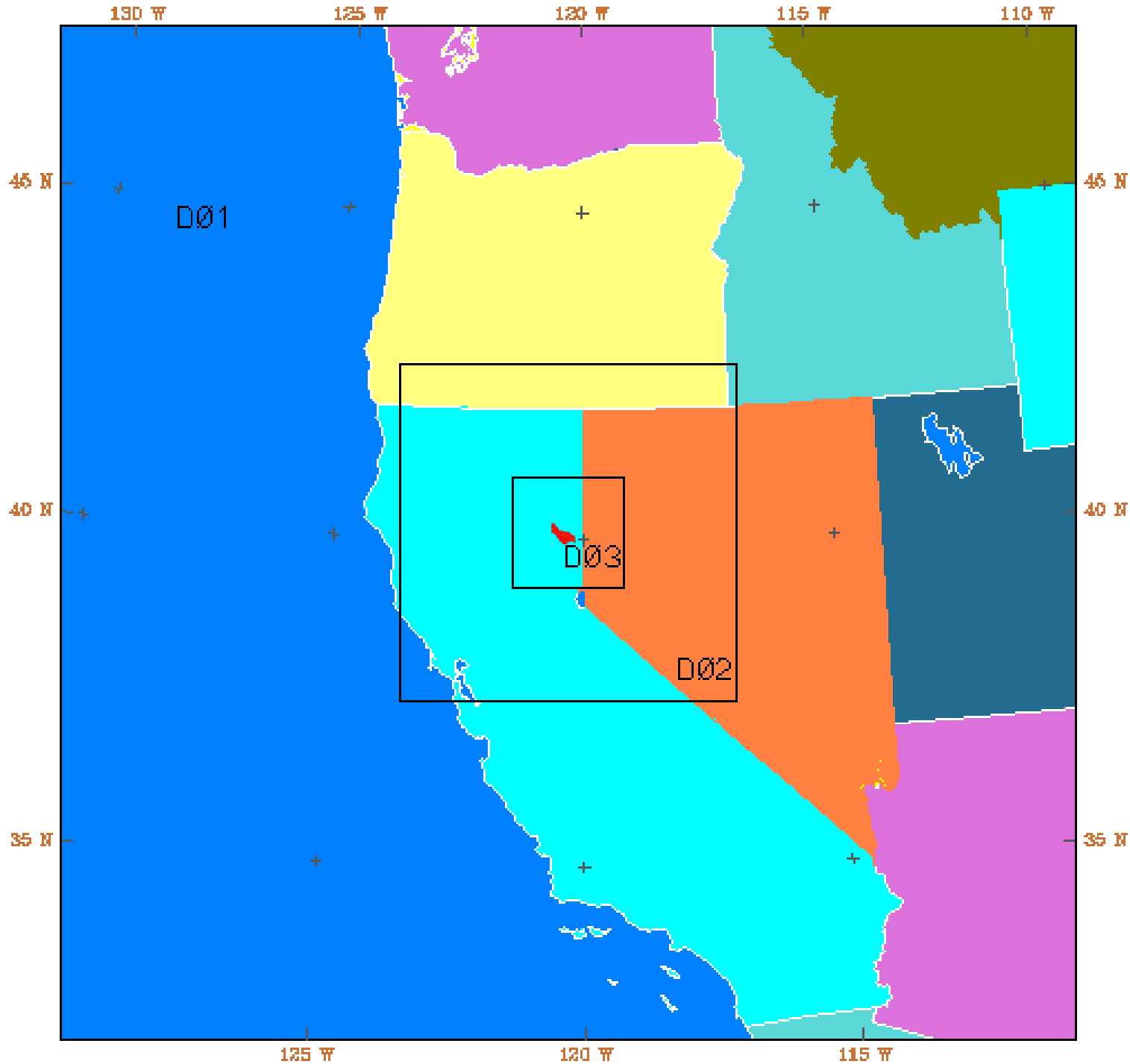


Estimated monthly LAI based on local vegetation survey and MODIS data



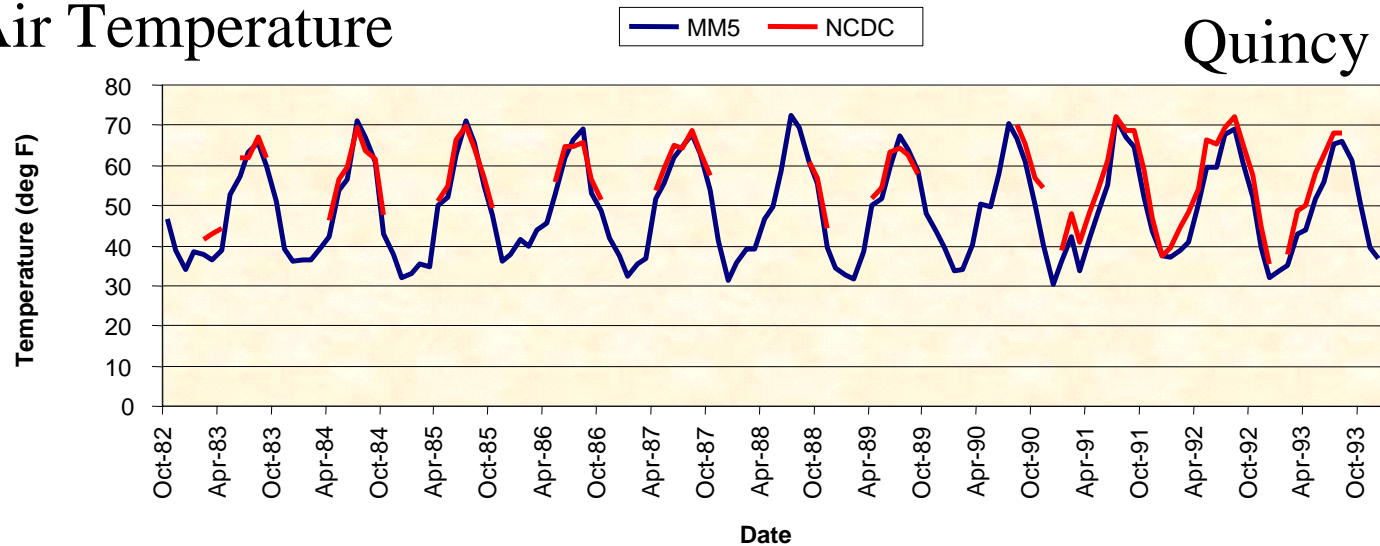
RECONSTRUCTION OF HISTORICAL ATMOSPHERIC DATA
OVER THE WATERSHED AT 9 KM RESOLUTION
BY
DOWNSCALING FROM COARSE RESOLUTION (~280KM)
GLOBAL DATASETS

MM5
Domain
Nesting
for
Last
Chance
Creek
Watershed
Model

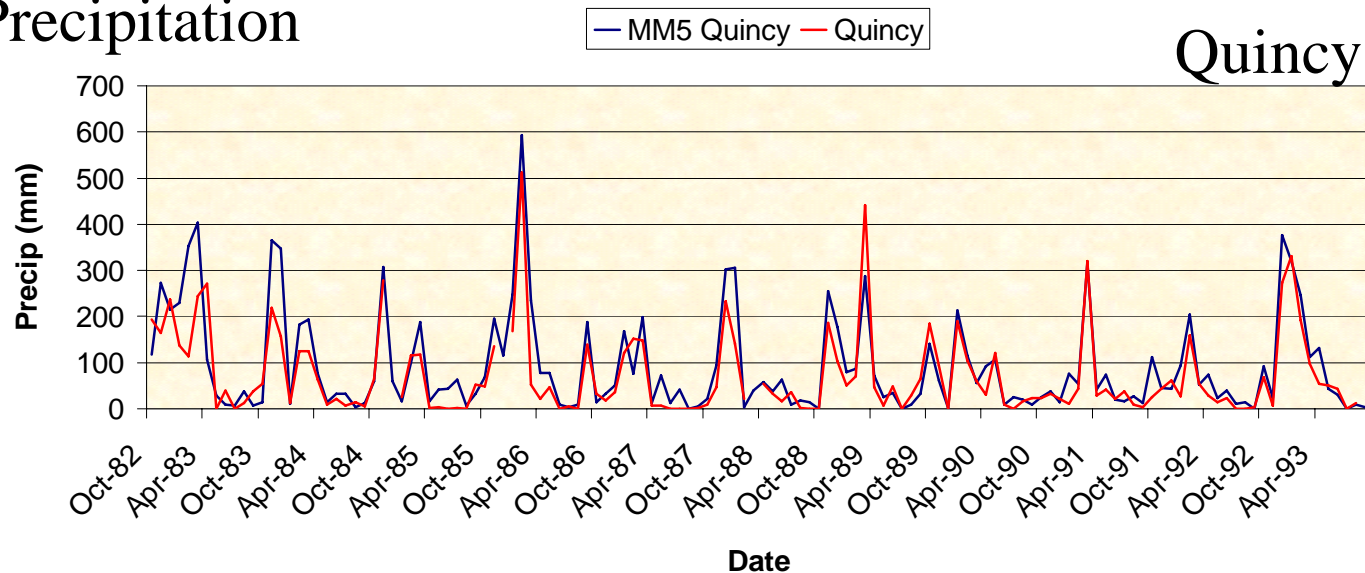


Reconstructing distributed atmospheric data for validation and for critical hydrologic periods

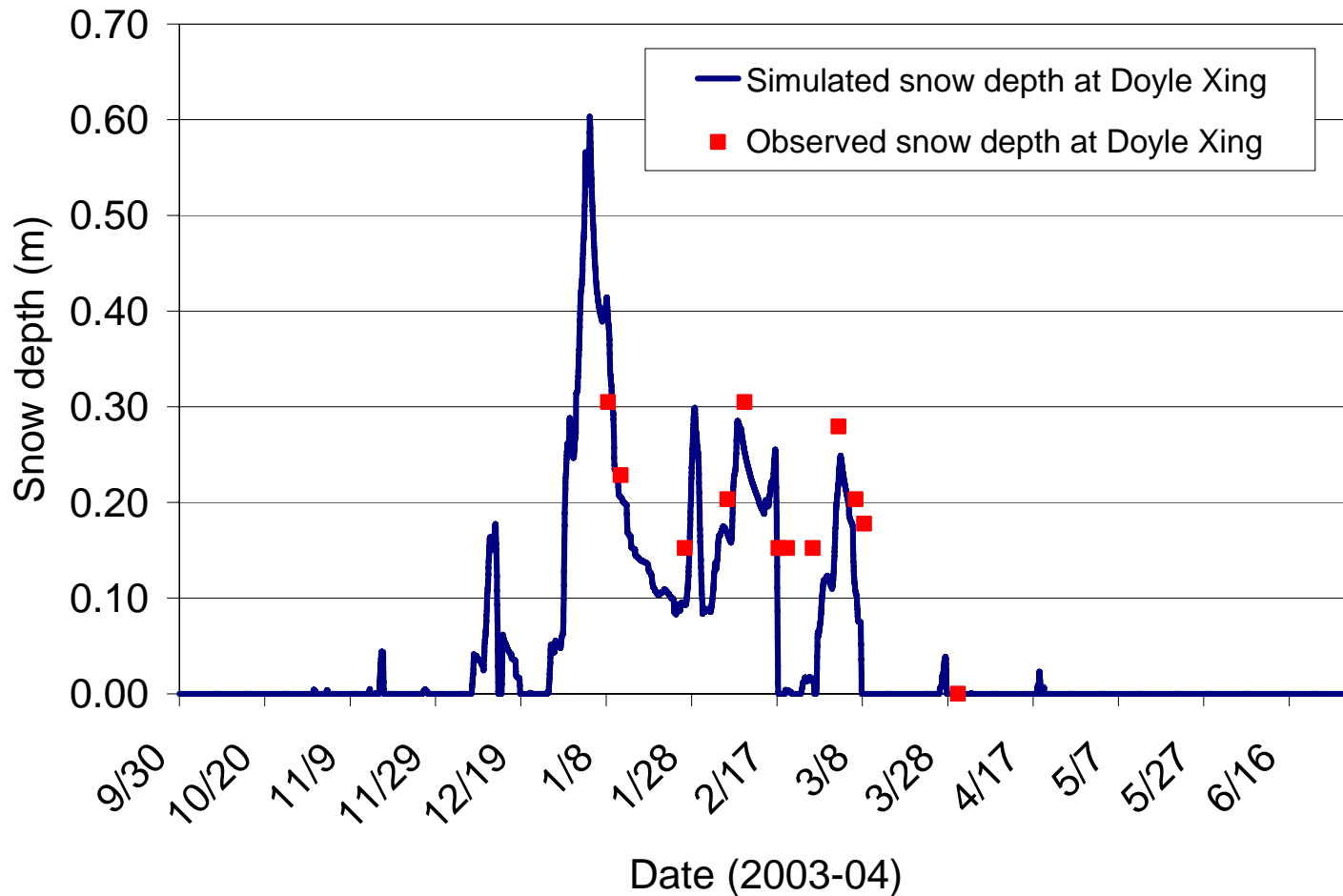
Air Temperature



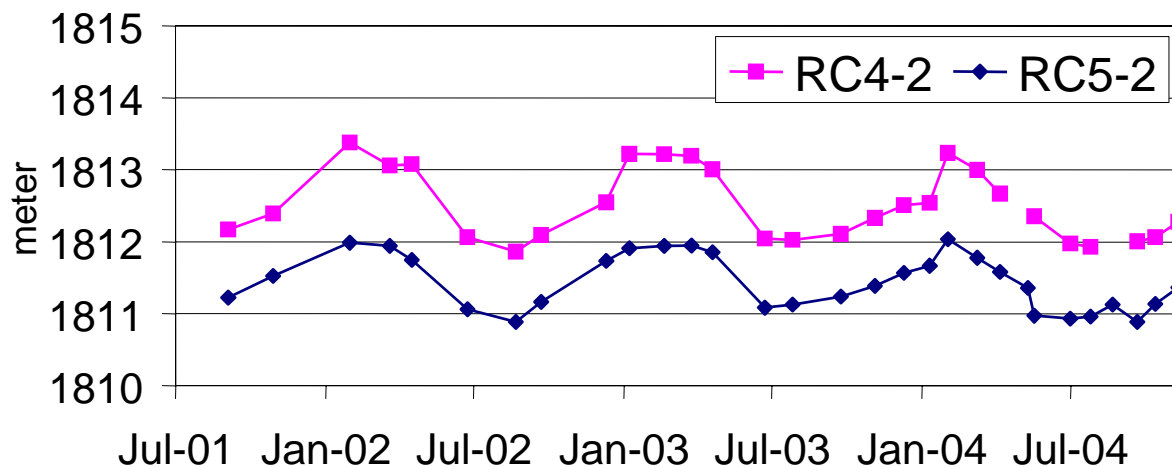
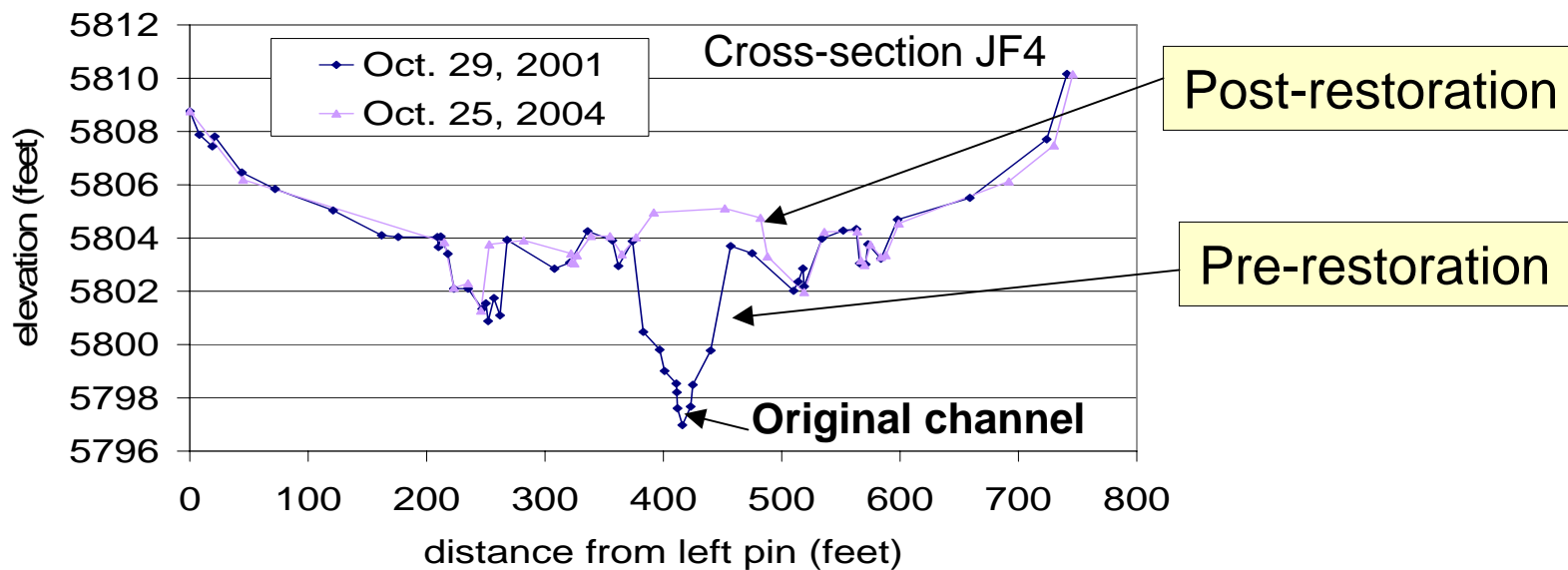
Precipitation



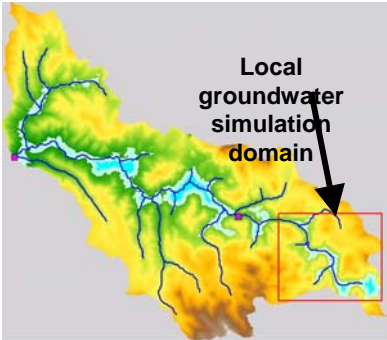
Snow module to simulate accumulation and melt processes of snow



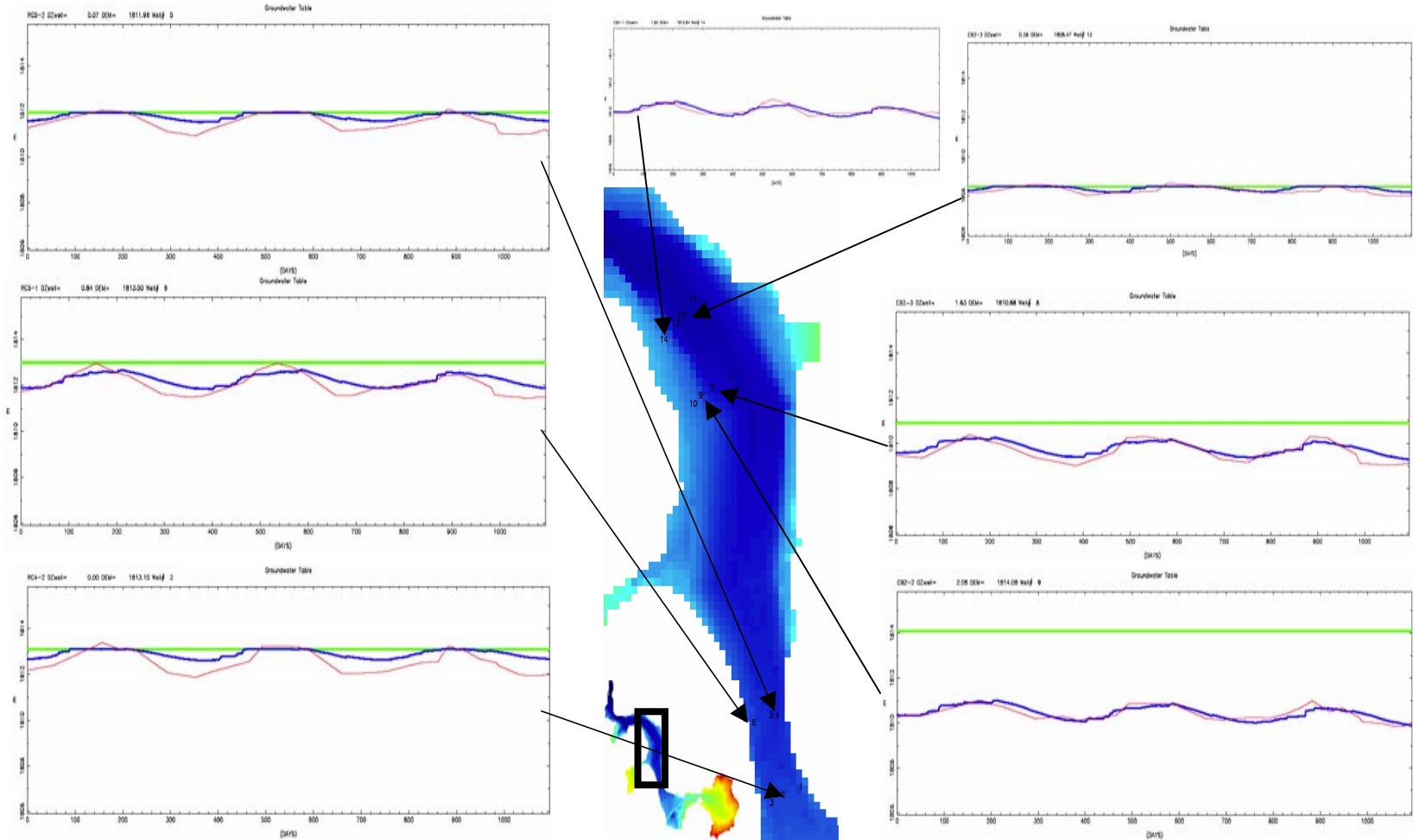
Monitored Data Collected for Model Validation



Local Groundwater Simulation at Rowland-Charles Reach (Oct 1, 2001 – Sep 30, 2004)



- Observed Groundwater Table
- Simulated Groundwater Table
- Ground Surface



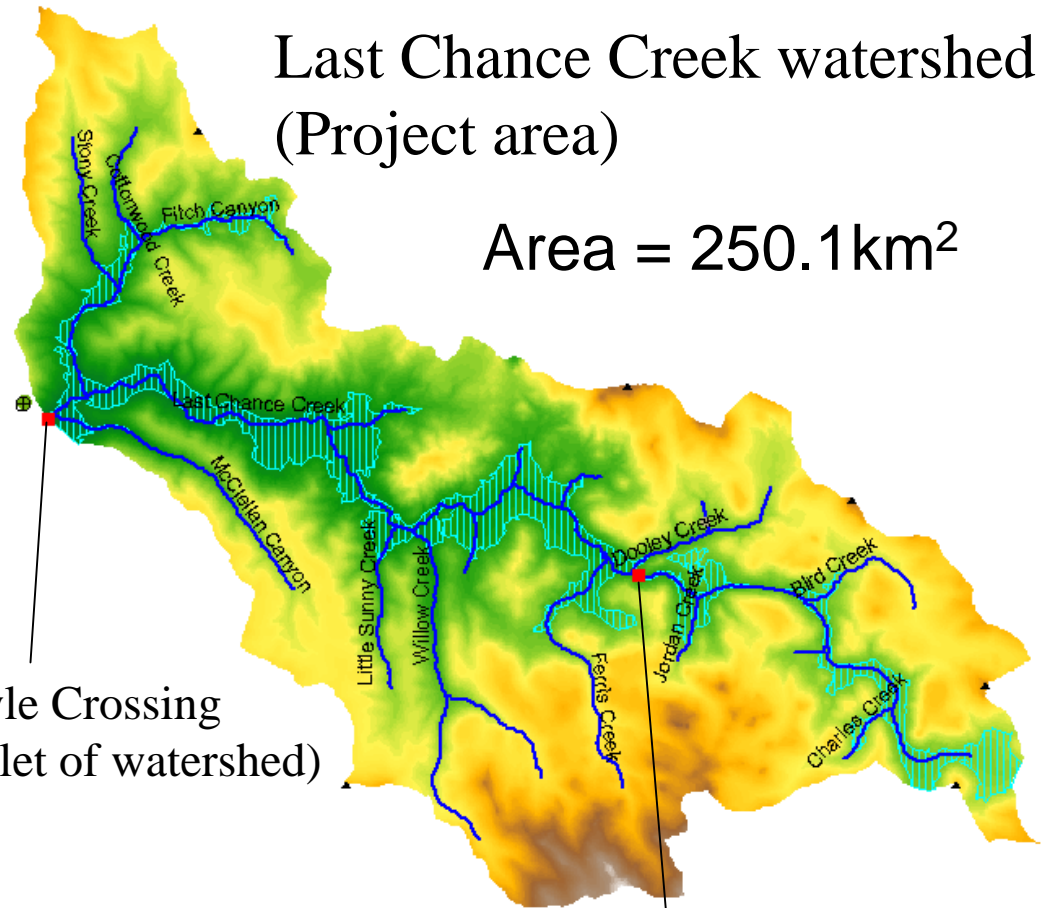
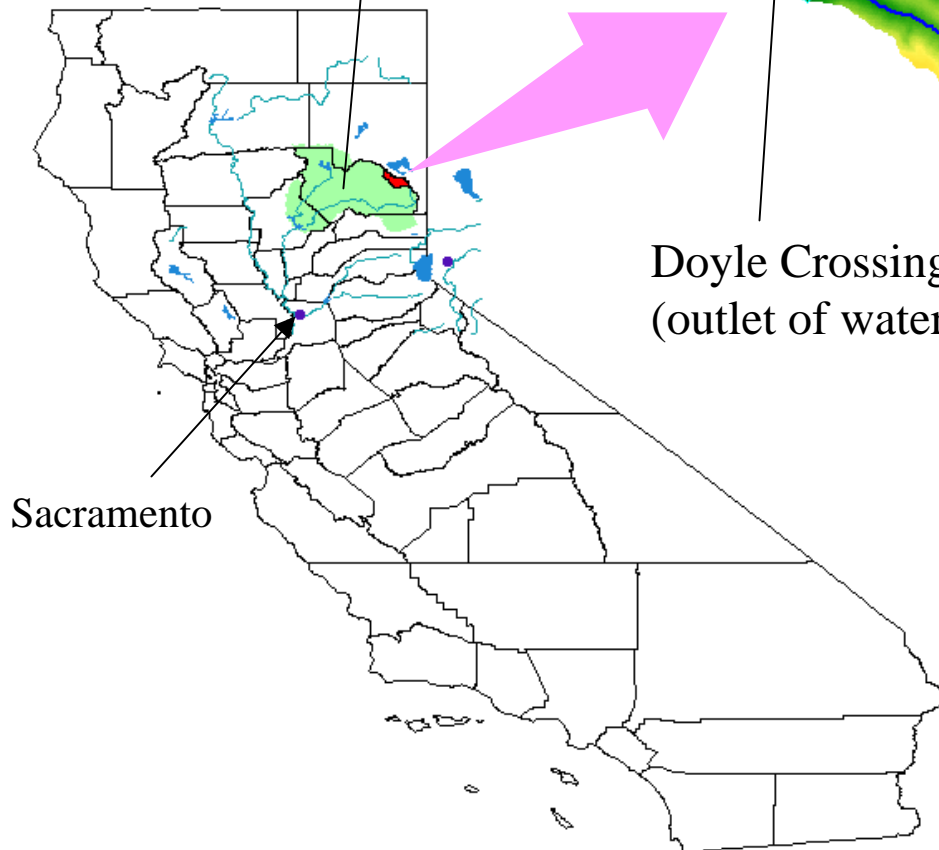
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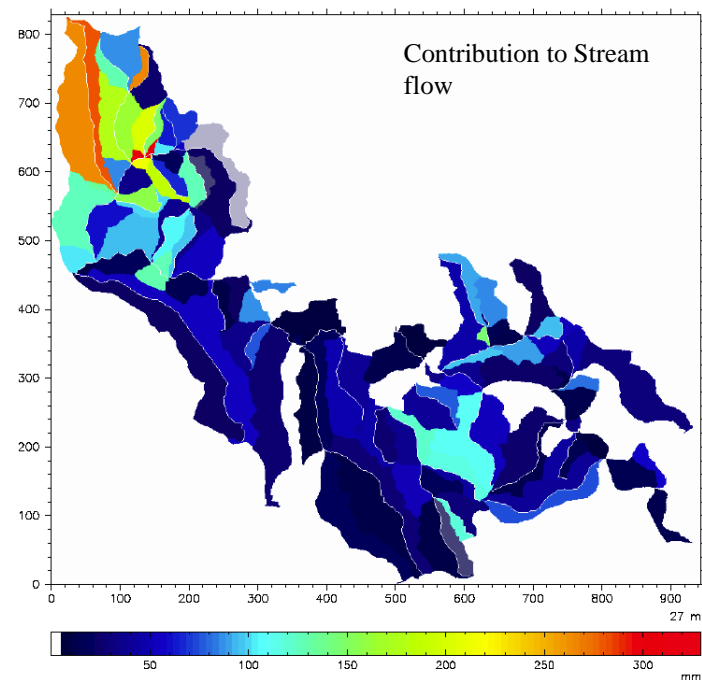
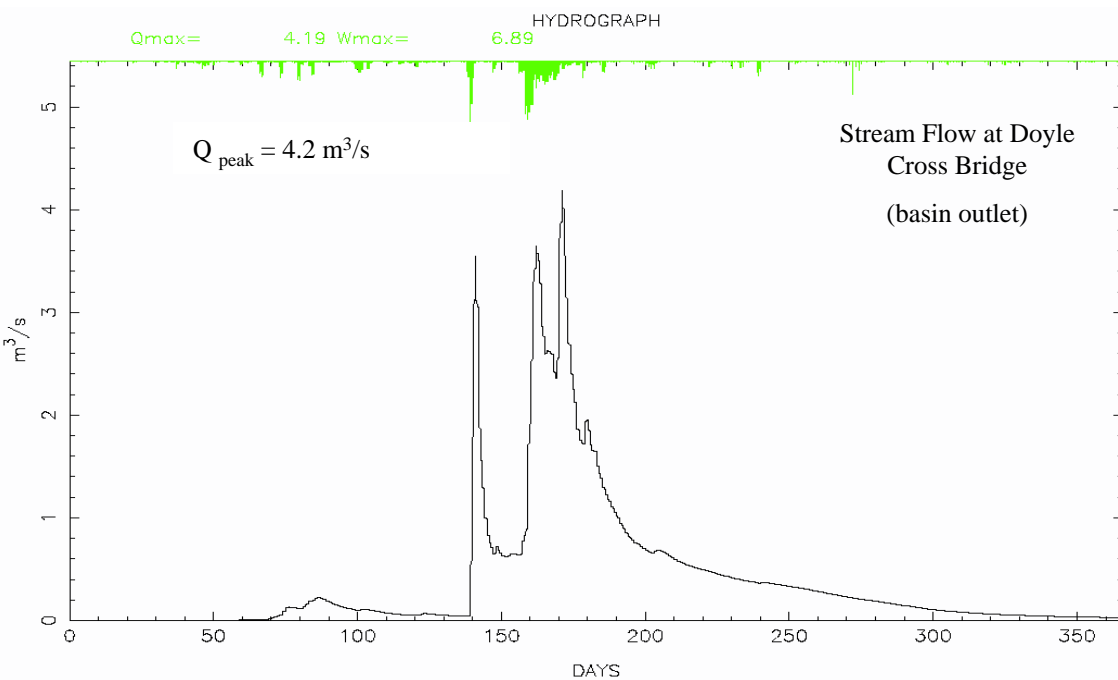
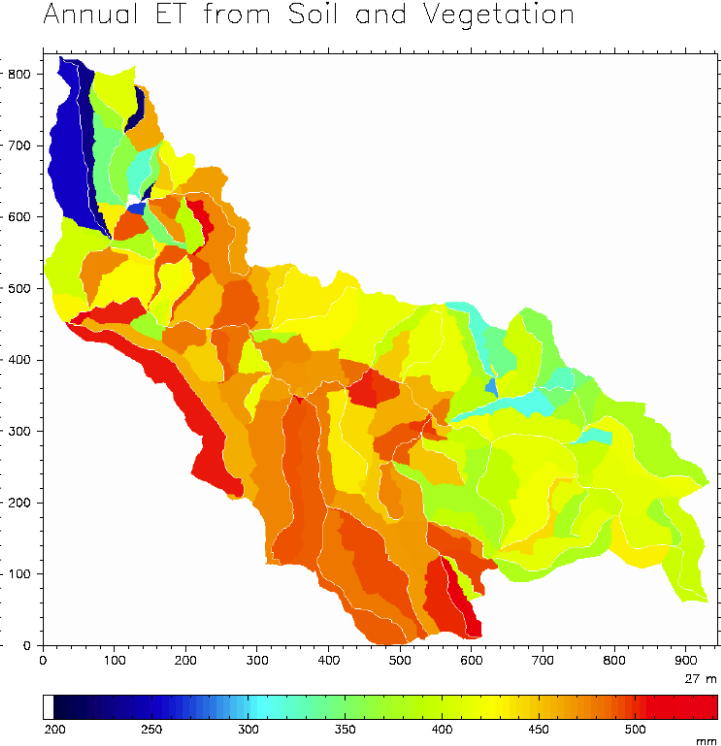
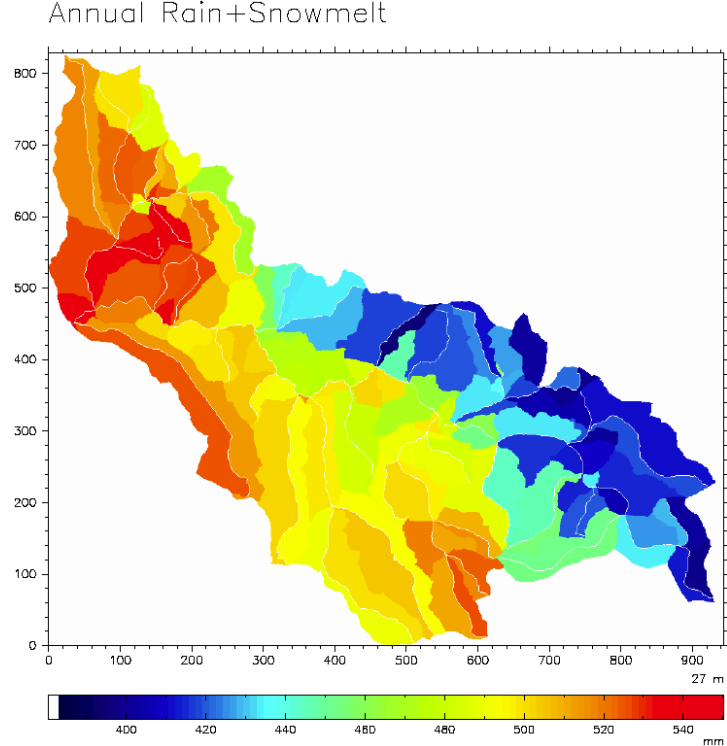
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Doyle Crossing
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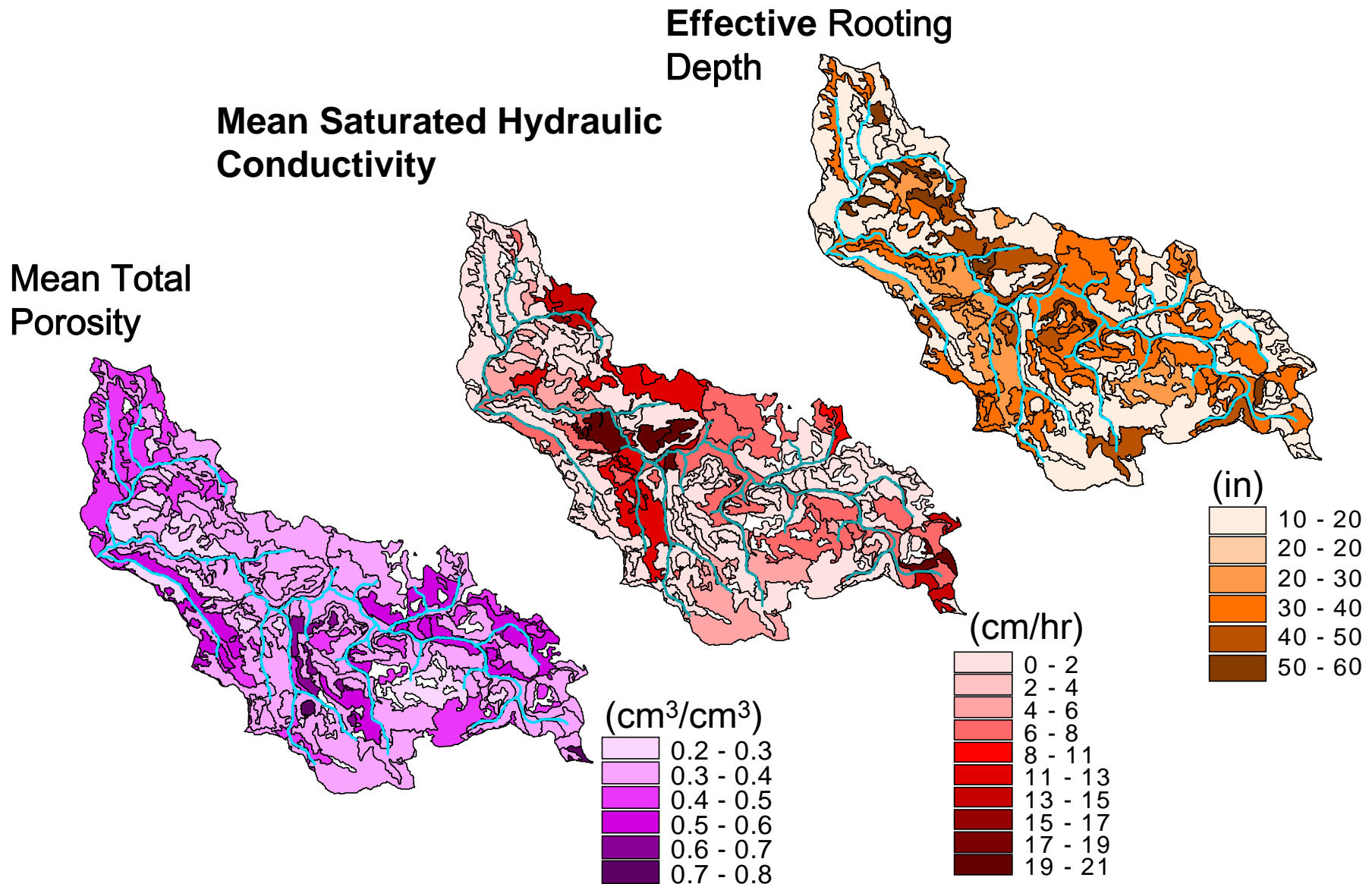
Million \$ Bridge



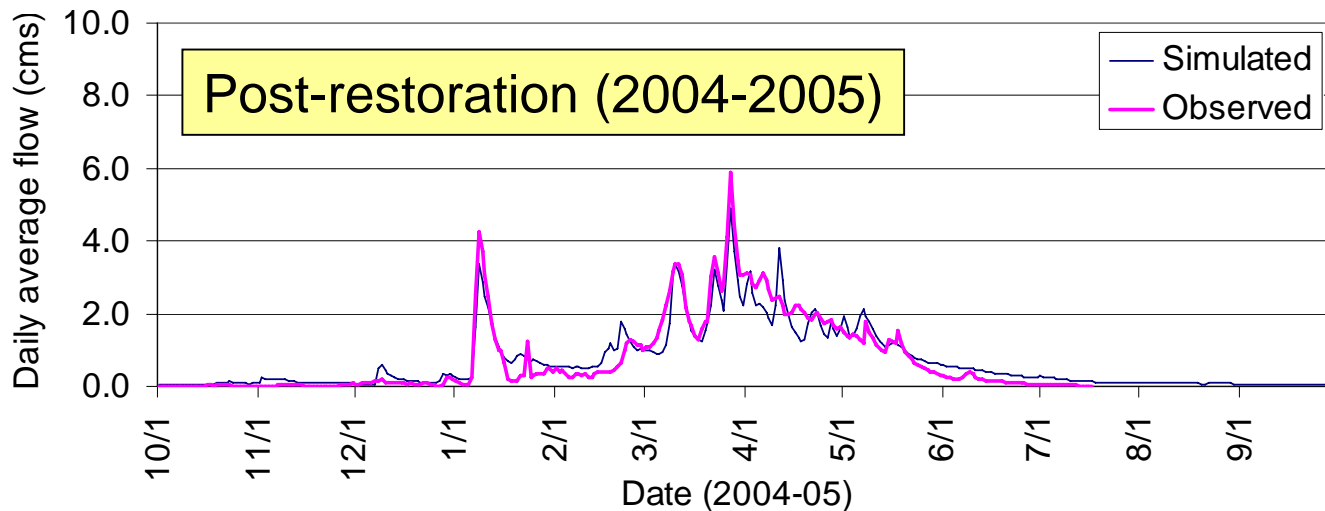
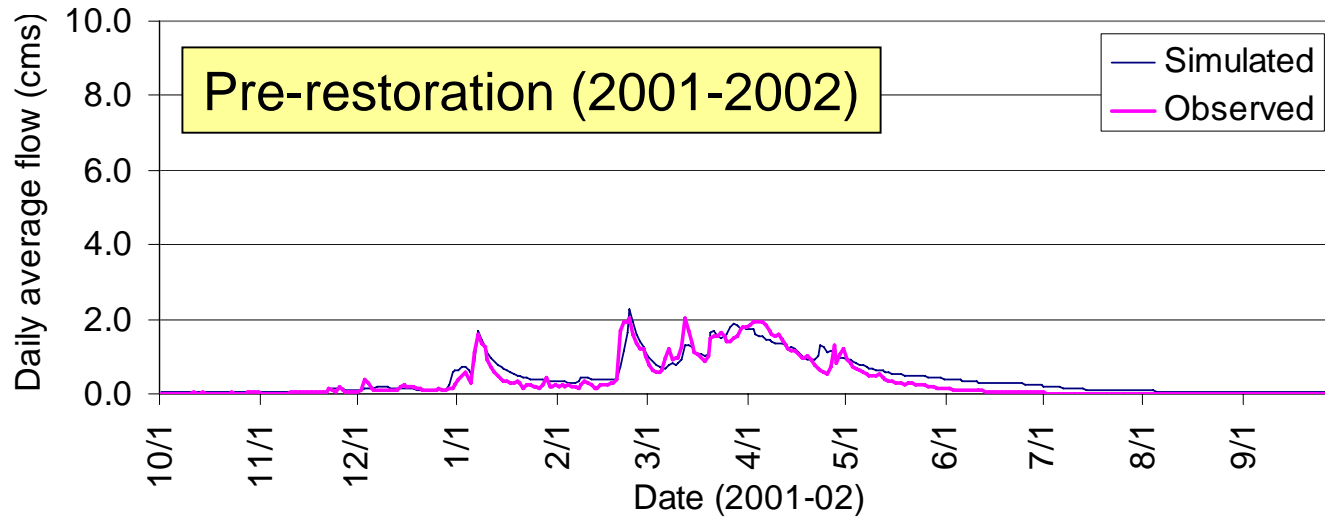
Simulated
Hydrological
Conditions
Water Year
10/2003-9/2004



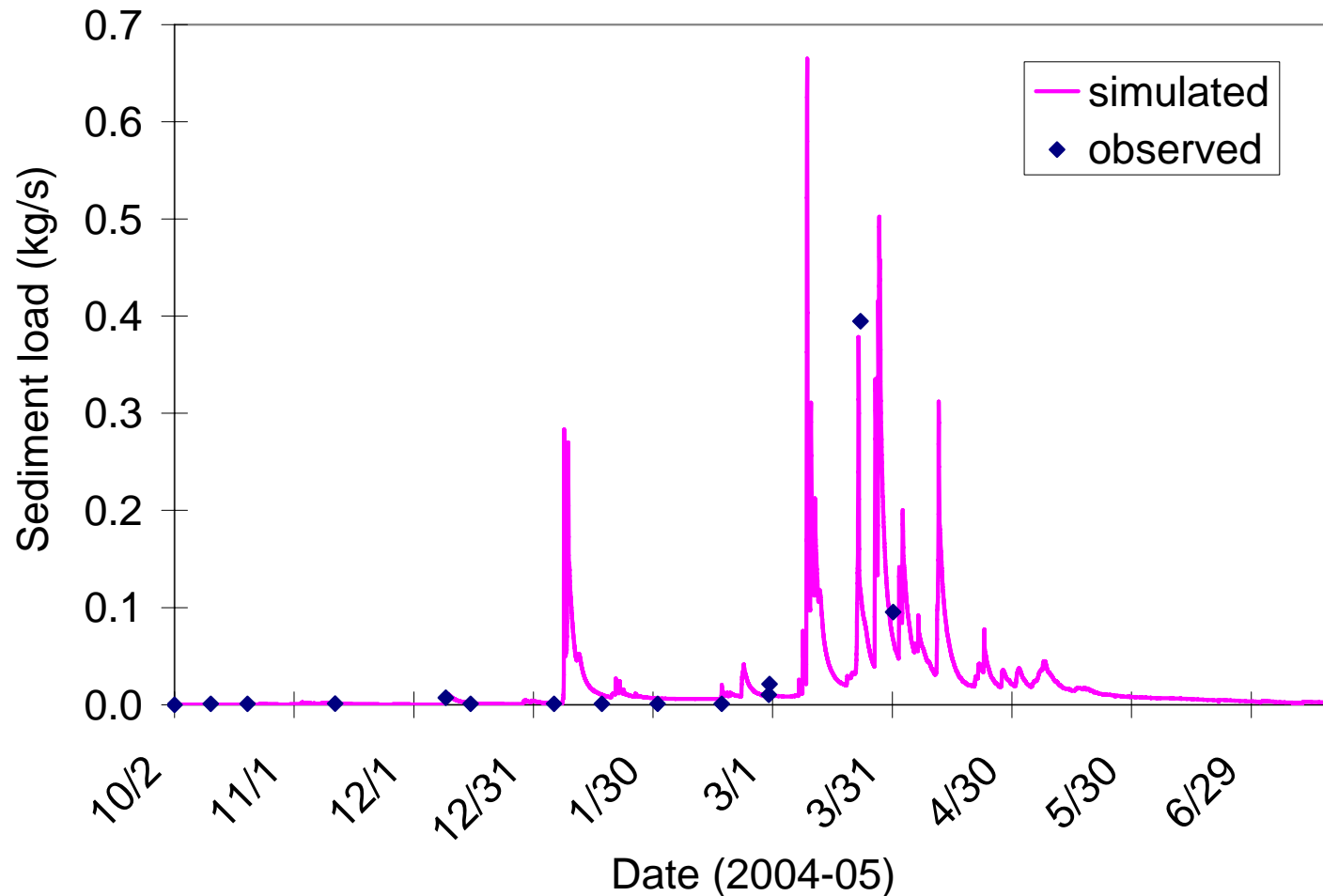
Estimated soil parameters for WEHY model over Last Chance Creek watershed (selected)



Comparison of model simulated and observed runoff at Doyle Crossing for Pre-restoration condition (Oct. 2001 - Sep.2002) and Post-restoration condition (Oct. 2004 - Sep.2005)



Comparison of model simulated and observed sediment load at Doyle Crossing for post-restoration condition (Oct. 2004 - Sep. 2005)



ASSESSMENT OF RESTORATION ACTIVITIES
IN
LAST CHANCE CREEK WATERSHED

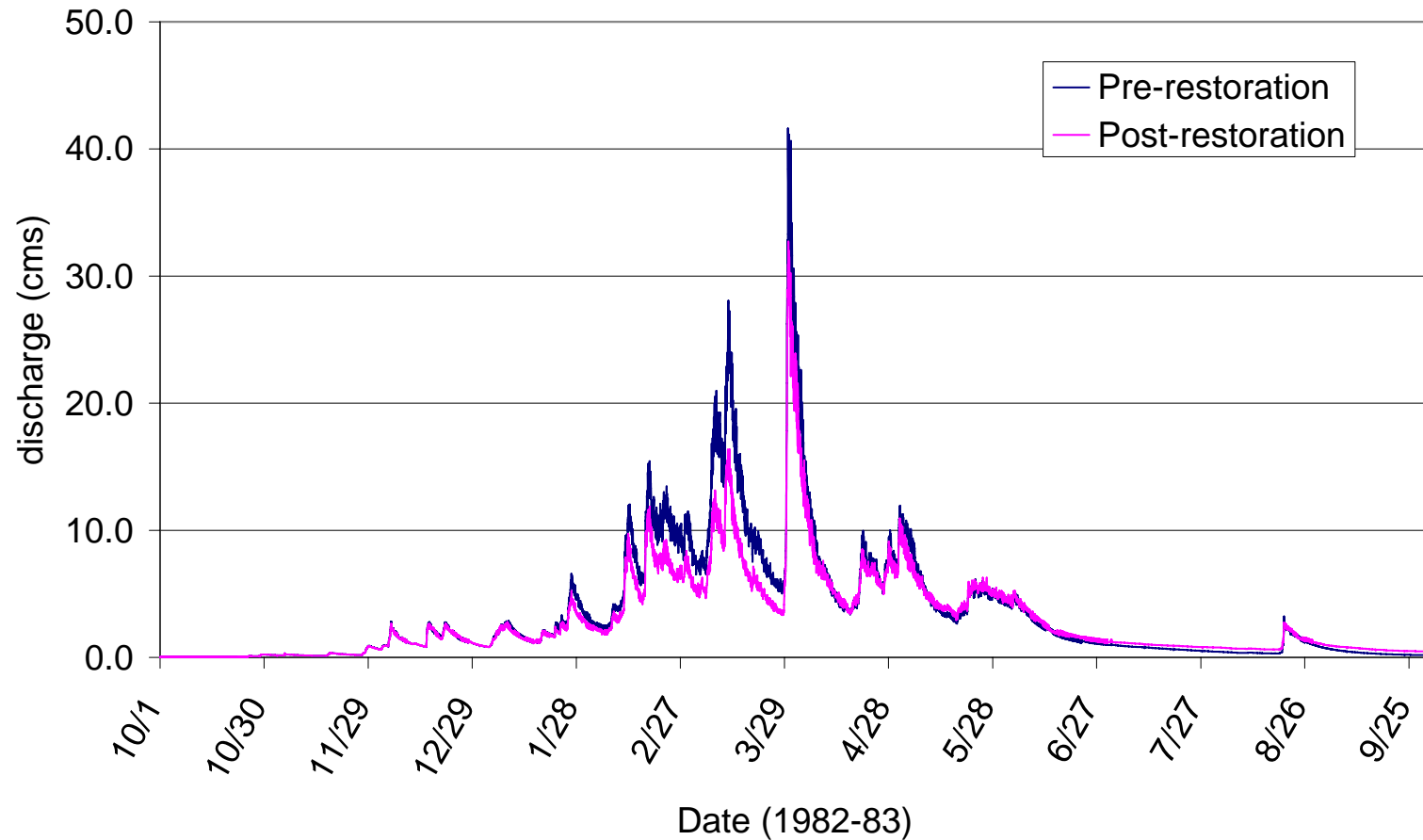
FOR TWO SCENARIOS:

- 1) PRE-RESTORATION CONDITION;
- 2) POST-RESTORATION CONDITION,

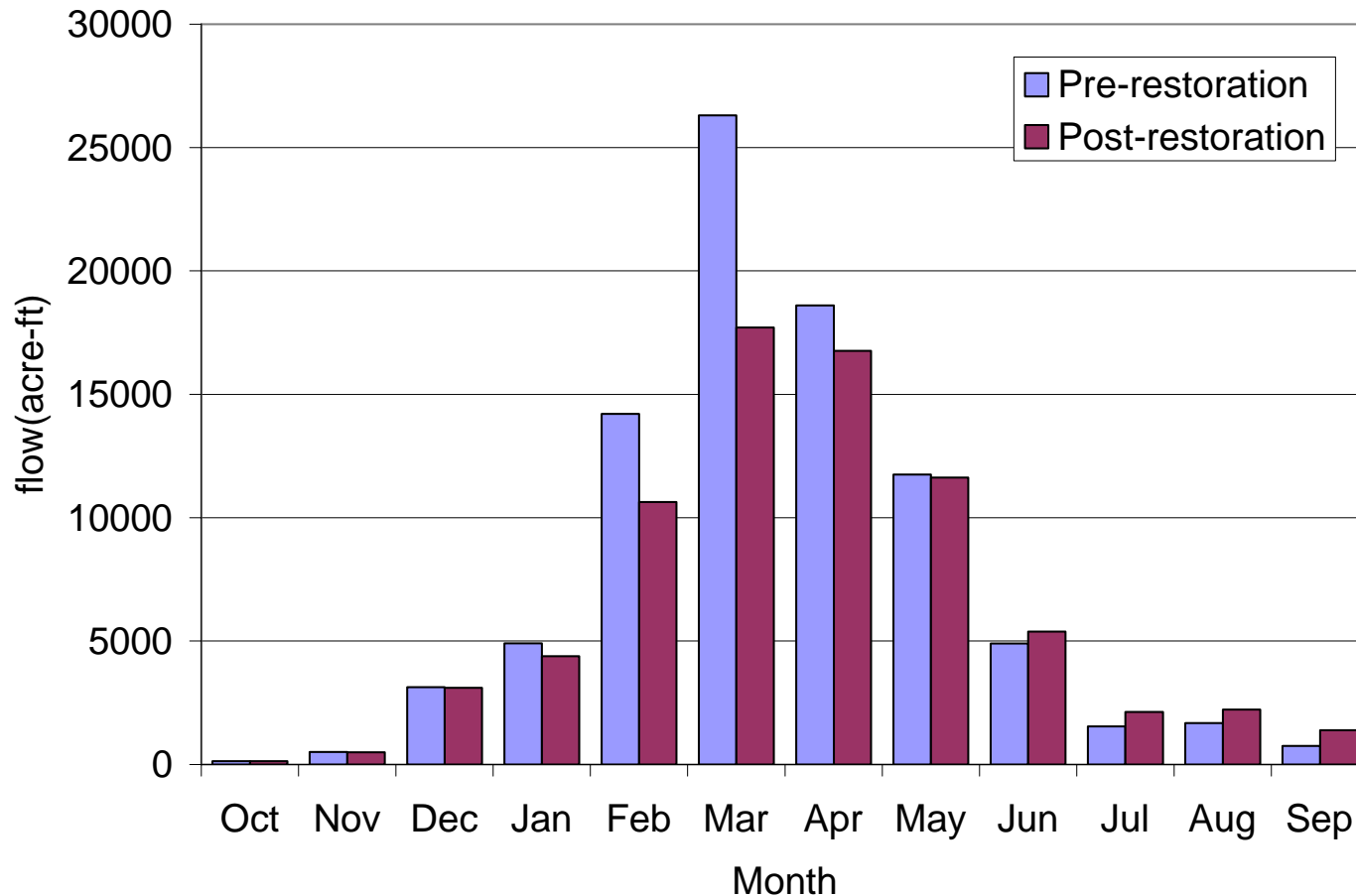
under the same atmospheric inputs
corresponding to wet water year
(Oct. 1982- Sep. 1983)

ARE
SIMULATED AND COMPARED.

Comparison of flow discharge at Doyle Crossing between the pre-restoration and post-restoration conditions (Oct.1982 - Sep.1983)



Comparison of monthly flow at Doyle Crossing between pre-restoration and post-restoration conditions (Oct. 1982 - Sep. 1983)

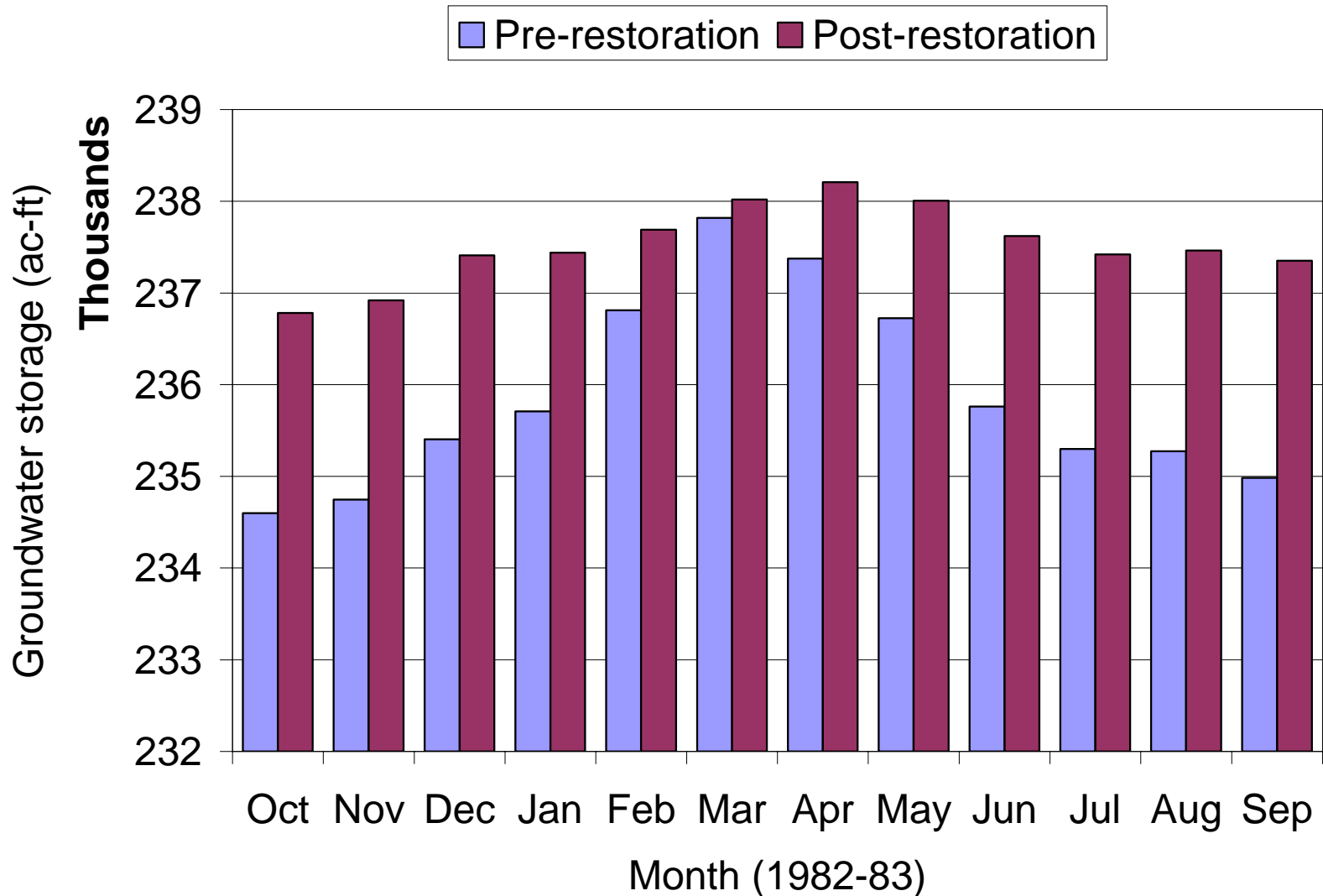


Assessment of restoration activities: Monthly Flow at the Doyle Crossing (Oct.1982-Sep.1983)

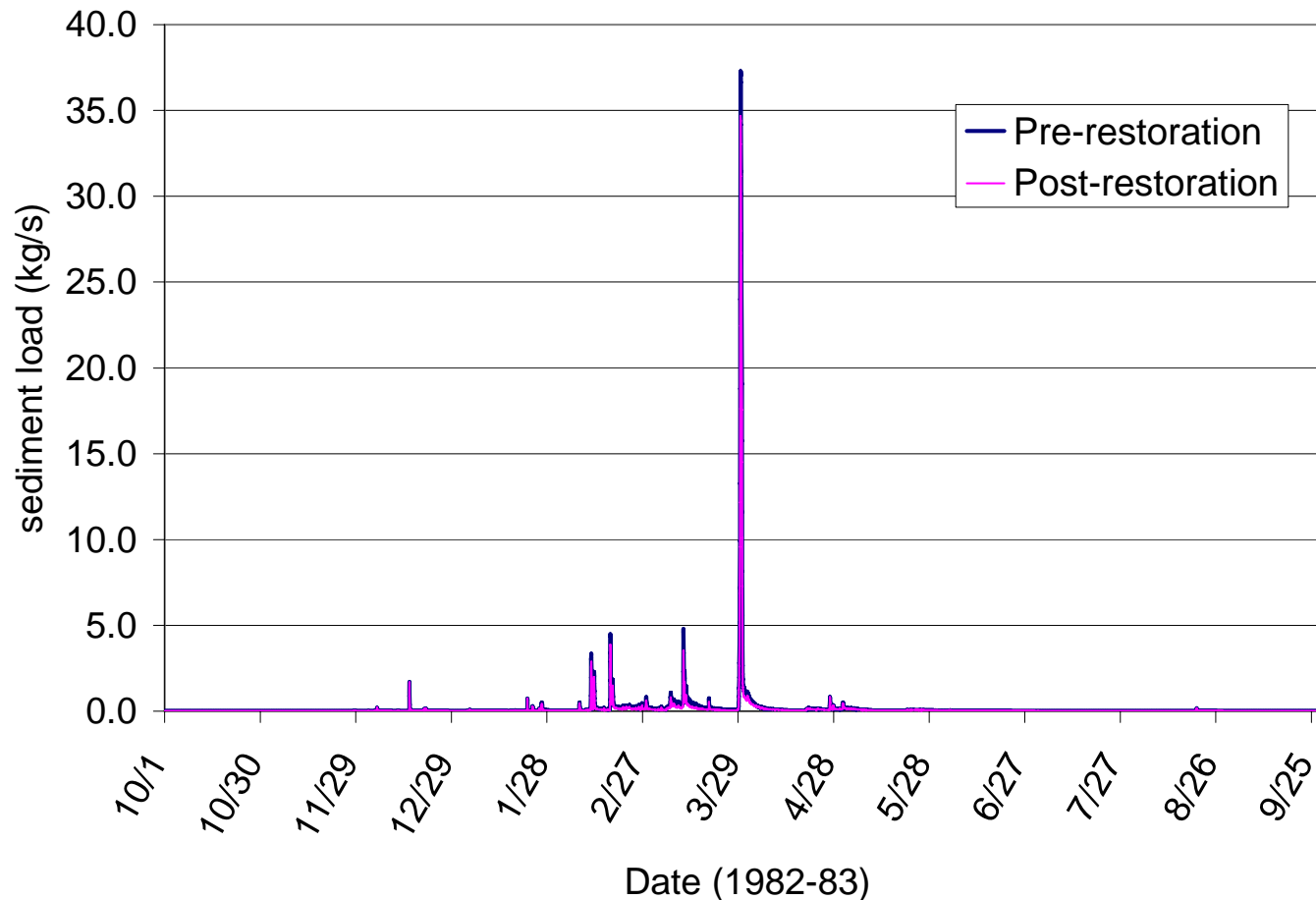
	Pre-restoration (acre-ft)	Post-restoration (acre-ft)	absolute diff (acre-ft)	relative diff (%)
Oct	132	132	0	0.00
Nov	505	499	-5	-1.06
Dec	3133	3109	-24	-0.77
Jan	4916	4388	-528	-10.74
Feb	14204	10631	-3574	-25.16
Mar	26302	17709	-8594	-32.67
Apr	18600	16762	-1838	-9.88
May	11744	11628	-116	-0.99
Jun	4898	5386	488	9.97
Jul	1545	2129	584	37.82
Aug	1680	2222	542	32.28
Sep	749	1393	643	85.84
Annual	88408	75988	-12420	-14.05

32.7% reduction of flow in March (wet month) may be expected, and
85.8% increase of flow in September (dry month) may be expected because of the restoration.

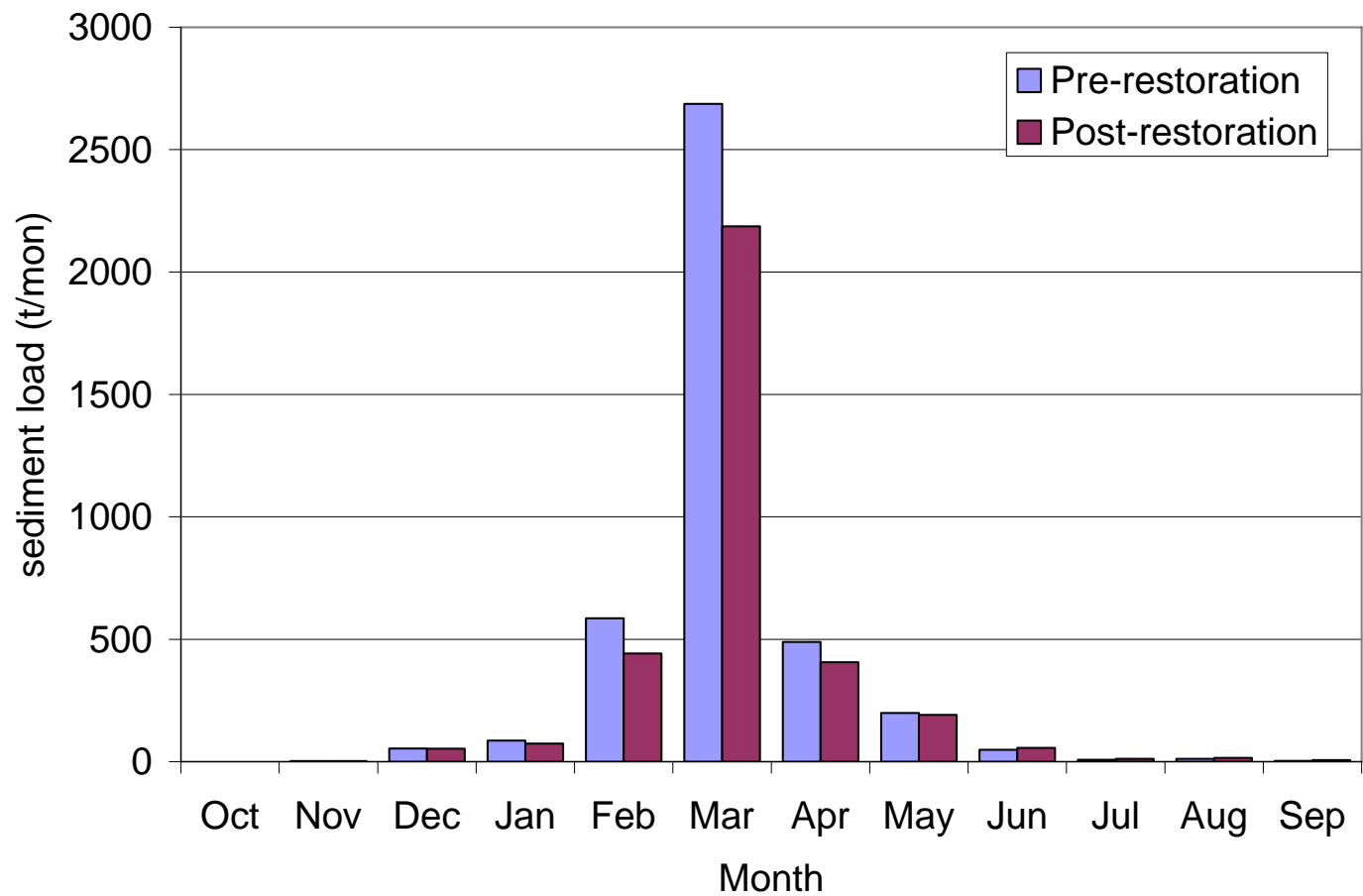
Comparison of monthly mean groundwater storage between the pre-restoration and post-restoration conditions (Oct.1982 - Sep.1983)



Comparison of sediment load at Doyle Crossing between the pre-restoration and post- restoration conditions (Oct.1982 - Sep.1983)



Comparison of monthly sediment load at Doyle Crossing between the pre-restoration and post-restoration conditions (Oct.1982 - Sep.1983)



**Assessment of restoration activities:
Monthly Sediment load at the Doyle Crossing (Oct.82-Sep.83)**

	Pre-restoration (t)	Post-restoration (t)	absolute diff (t)	relative diff (%)
Oct	0.2	0.2	0.0	-0.59
Nov	2.1	2.1	0.0	-2.02
Dec	53.7	53.0	-0.7	-1.37
Jan	85.6	73.2	-12.4	-14.45
Feb	585.3	442.0	-143.3	-24.49
Mar	2687.2	2186.4	-500.8	-18.64
Apr	489.1	406.2	-82.9	-16.94
May	199.5	191.1	-8.4	-4.19
Jun	48.9	55.6	6.7	13.62
Jul	7.2	11.4	4.3	59.24
Aug	11.8	15.3	3.5	29.74
Sep	2.7	6.2	3.5	133.46
Annual	4173.3	3442.8	-730.5	-17.50

17.5% reduction of annual sediment discharge may be expected because of the restoration.

Conclusions

1. WEHY (Watershed Environmental Hydrology) Model has been applied to the Last Chance Creek Watershed for the Assessment of the Impact of Restoration Activities on the Water Supply/Flood Control/NPS Pollutant Discharge;
2. WEHY Model demonstrated that restoration activities in Last Chance Creek will store more water during wet periods (reducing flood discharge) while increasing base flows during dry periods; groundwater storage in the watershed will increase by the restoration activities;

3. WEHY Model also demonstrated that the undertaken restoration activities will reduce the sediment discharge from Last Chance Creek watershed.
4. WEHY Model can be applied to any watershed in California for the assessment of restoration activities.

Acknowledgement:

This study was funded by CALFED Watershed Program.